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HIGHER TECHNOLOGICAL EDUCATION IN BRITAIN

AMONG the unanimous recommendations of the report of the Percy Committee on Higher Technological Education, that for the establishment of a national council of technology received widespread support, and after announcing his intention to implement this recommendation, the Minister of Education in September 1947 appointed a 'working party' under the chairmanship of Mr. D. R. Hardman to advise on the establishment of a national council and on the principal steps to that end. All ten regional councils and academic boards recommended by the Percy Committee have already been constituted. National colleges have been established in several branches of technology and others are contemplated in the near future. Local education authorities were directed in Circular 133 issued by the Ministry of Education on March 19, 1947, to prepare their schemes of further education and plans for county colleges, as the basis for national action along the lines of the Education Act of 1944 ; and although here, as in the expansion of the universities, restrictions on building may hinder development, that delay affords a further opportunity for considering the long-term plans for the expansion of higher education as a whole.

The first meeting of the 'working party' revealed a large measure of agreement both on the general issue and on major questions of detail among its members. The 'party', which included Dr. J. E. Myers, Dr. A. E. Trueman, and Mr. F. W. Lawe, was satisfied that the case for setting up a national council had been established and recommended that steps be taken to that end with as little delay as possible, so that developments in training technologists as well as craftsmen, technicians and others may proceed along sound lines.

It is proposed that the general function of the national council should be to advise the Minister of Education on the national aspects of regional policy ; and although it will be an advisory and deliberative body, the possibility of executive functions, for example, such as might be involved in the certification of technological courses of graduate standard, is visualized. The 'working party' does not, however, altogether agree with the proposal in the Percy Report that the national council should be advisory to the University Grants Committee as well as to the Minister of Education. It is pointed out, quite correctly, that the University Grants Committee is itself the appropriate committee to advise the Government and to carry out certain defined functions in its own field. It is also true that the University Grants Committee has a province of its own separate from that of the proposed council ; but it is by no means clear from this report where confusion will arise if the University Grants Committee is formally dependent for advice on technological education on the new council. The 'working party' recognizes that the closest consultation should exist between the University Grants Committee and the proposed new

council in all matters of common concern, but it believes that this can be best achieved by the establishment of a joint committee of the Council and the University Grants Committee. No clue is given, however, to the responsibilities or terms of reference of such a joint committee, other than that it will deal with "matters relating to education of University standard". Since two specific functions of the council in respect of which it should advise the Minister of Education, namely, the planning of new developments, including national colleges, and the development of appropriate research in colleges, are listed separately, it would seem that the 'working party' has missed the point of this vital recommendation of the Percy Committee.

Even if Great Britain's resources of trained teachers of science and technology were not severely limited, and there were no severely competitive demands for trained man-power, the expansion of higher technological education and of the universities could not proceed independently without some close overall review, if not, indeed, a system of priorities. The expansion of technical colleges involves demands for equipment as well as buildings at precisely the point where university expansion is at present most handicapped. A link ensuring that the University Grants Committee is fully informed on proposals for higher technical education would seem almost essential.

Similar considerations apply to the question, which has been widely canvassed in recent years, of the development in Great Britain of institutions of the type of the Massachusetts Institute of Technology. Such developments must be evaluated from the point of view of university education as a whole, and also from that of technical education and the research organisation of the country. It should be remembered, moreover, that many industries look to the universities and not to the technical colleges for their leaders; and while the raising of the status of the technical colleges may tend to alter the balance, it is still true that as the scientific character of an industry becomes more pronounced, its demand for technologists tends to decrease and that for trained men of science to increase.

While the universities and the technical colleges, from the point of view of the expansion required for teaching and research, are in sharp competition with one another and with the demands of industry and of Government research establishments, the existing organisation which leaves the universities entirely outside the responsibilities of the Minister of Education, however logical and justifiable from one point of view, provides no obvious means for the overall review of resources. Such a review is imperative in order that duplication and waste of effort may be avoided and the output of technologists and of scientific workers related to real demand. The Percy Committee, as its report implicitly shows, was aware of this need; but admittedly it will not be easy to devise appropriate organisation to serve the need. Even in respect of teaching, account must be taken, as the Percy Committee also recognized, of the research associations and like institutions. Indeed, it seems that the Committee, in stressing the importance of bringing the research associations themselves into the closest possible relations both with the regional academic boards and with the national council, was aware of their value to industry as sources of trained technologists and scientific workers as much as from the research work actually carried out in their laboratories. From the point of view of technical education and the supply of technologists to industry, the position of the research associations requires appraisal, for it is as important as their contribution to the research structure of Great Britain.

The urgent need for closing this gap in the evaluation of universities, technical colleges and other institutions as suppliers of technologists and scientific men for industry, even if by some temporary expedient only, seems to have escaped the 'working party', in spite of its recognition that a national body is required which can advise on all questions bearing on education for industry and commerce, including training for the professions of management and for design in relation to industry and commerce. Even there, however, it would limit the responsibility of the national council to such aspects of those wider functions as fall within the jurisdiction of the Minister of Education. Nevertheless, it is recognized that technical and commercial education is a whole, from craftsmanship to management, and that problems in different parts of the field are interdependent; it is considered impracticable to extend the scope of the council to cover the whole field of further education. Accordingly it is recommended that the council should be entitled "The National Advisory Council on Education and Commerce". Indeed, the general impression left by the report is that departmentalism has considerably restricted the 'working party's' vision. The imagination and perspicacity which characterized the paragraphs dealing with the technical colleges in the Nuffield College Statement on "Industry and Education" five years ago are sadly lacking.

Detailed recommendations for the constitution of the proposed council are appended to the report. Besides the representatives of the regional councils and regional academic boards constituting the majority of the council, it is proposed that the Minister of Education should have the right to select the chairman and to appoint directly up to twenty members to ensure that important branches of technical and commercial education are adequately represented, and also, at his discretion, assessors from Government departments. The council would work through a competent standing committee of up to twenty-four members, with such advisory subcommittees as may be required, and provided with secretarial and other staff and office accommodation by the Ministry of Education.

There can be no doubt that even within the limited field visualized by the 'working party', the proposed council should do much to support and co-ordinate the efforts of regional councils to improve the status, the resources and the work of the old technical colleges, and to ensure that regional and local needs are adequately served both in respect of teaching and of research. It remains to be seen whether the

national council itself will prove able to resolve the main difficulty of the qualifications to be awarded by colleges of technology, on which the Percy Committee itself was sharply divided. On this one point also the Percy Report contains ample evidence of the importance of establishing, at a high level, some interdepartmental means of obtaining an overall review of university needs and requirements and of those of the technical colleges, in relation to the country's needs and resources, even if only as temporary expedient until the broad lines of policy in university expansion have been determined and conditions permit that policy to be implemented without recourse to a system of priorities. There are questions here which concern not merely the Minister of Education but also the Minister of Labour and National Service and the Lord President of the Council, quite apart from the Chancellor of the Exchequer and the Minister of Works. Whether or not they can be resolved in part by the Advisory Committee on Scientific Policy or some other means without the establishment of a temporary special body remains to be seen. The departmental swathing in which the 'working party' would bind the new National Advisory Council on Education for Industry and Commerce would seem to preclude a resolute attempt to deal constructively with the problems of technical education in Great Britain.

GERMAN WAR RESEARCH

German Research in World War II

An Analysis of the Conduct of Research. By Colonel Leslie E. Simon. Pp. xi + 218. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 24*s*. net.

THERE are many lessons to be learnt in all fields of military art from a study of the conduct of the Second World War, but many of these will be out of date and misleading in ten years time. The important lessons are those which will remain true because they depend upon human nature and not on the particular stage of scientific and technical development at the time. Under this heading comes the question as to why Germany, whose men of science and engineers are among the best in the world, failed to mobilize fully her scientific and technical resources until it was too late for them to be effective. Colonel Simon's book sets out to give a review of their major achievements during the War, and to give also the principal reasons for their successes and failures, particularly from the point of view of the organisation of research and development.

Such a book must inevitably be handicapped by considerations of security, but the author gives an account of the more important weapons developed by the Germans on the air and army sides—naval weapons are not mentioned. This will be of considerable interest to the non-military scientific worker. To the man of science interested in British war developments, however, the most important chapters are those giving an account of the German organisations for research, development and testing, and their relation with the army and the production ministries.

Few will quarrel with Colonel Simon's main thesis that it was lack of liaison between the scientific and military staffs which led to the wastage of scientific and technical effort in developing unpromising projects, and in the frittering away of energy on a number of spectacular but strategically inferior weapons. Where the ultimate blame for this lay is not made clear by the author. One cannot help feeling that a deeper analysis would trace this lack of contact and understanding to two main causes: first, to the over-confidence of the military leaders after the initial success, which led them to neglect the development of weapons which would be necessary for the successful prosecution of the later stages of the War; secondly, to the "Führer Prinzip", which does not encourage the objective discussion and analysis of military requirements, bringing together the scientific man, production engineer and military staffs at the highest level. It may very well be that the German magnetic mine was a blessing in disguise to Great Britain, because its early defeat established the reputation of the scientific investigator with the public and the military, whereas in Germany it was the army, supported by the air force, which had all the initial success.

Colonel Simon points out another important circumstance which led to the development of weapons which were unsatisfactory either from the performance or the strategic point of view. This was the existence of a powerful armament industry with its own research and development establishments, which was able to put over its own ideas and projects without their being tested by an effective and impartial group at a central proving ground.

This book will be of great interest to all scientific men who work in, or have worked in, experimental establishments; it will be of even greater interest to those who have also worked at the headquarters of the services or supply ministries. It contains an admirable account of the conditions under which the German men of science worked, which were excellent from the point of view of equipment and amenities, but deplorable in the lack of real co-operation from the military leaders.

MODEL RESEARCH IN HYDRAULICS

Scale Models in Hydraulic Engineering

By Prof. J. Allen. Pp. 407 + 35 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1947.) 30*s*. net.

THIS is the book of the Manchester School for hydraulic model research, closely connected with the names of Reynolds, Gibson and Allen. The hydraulic model experiments begun here by Osborne Reynolds in 1885 were most probably the first systematic attempt in this line. It was not until the very last few years of the nineteenth century that Engels introduced this work on the Continent, and nearly thirty more years elapsed before John R. Freeman convinced the American hydraulic engineers and others that hydraulic model research on a great scale is a powerful means of solving problems connected with many hydraulic constructions.

Nowadays there are more than a hundred hydraulic laboratories engaged upon this work. These laboratories can be divided into two groups, very unequal in numbers: the overwhelming majority in the United States and on the Continent of Europe, using big models, and the British laboratories, which seem

to have the monopoly of the really small-scale models.

It is well known that the chance of discrepancies between the model and the prototype increases as the scale-ratio is higher. Prof. Allen devotes a large part of his book to proving that models with very high scale-ratios can be used with success, provided they are well-designed and operated judiciously. These models always have to be strongly distorted: the reduction of the horizontal dimensions (x) is much more pronounced than that in the vertical direction (y). In extreme cases the vertical exaggeration ($x : y$) has been a hundred and more: in the first Severn model, $x = 40{,}000$ and $y = 366$; the Seine model of Vernon Harcourt was characterized by $x = 40{,}000$ and $y = 400$. At present these very high ratios seem to be confined to preliminary experiments which may help in designing another larger model. In the latter, x may vary between 2,500 and more than 10,000; y from 60 to 400; $x : y$ from slightly more than 10 to 85.

A typical example of a successful model of this type is the Rangoon tidal model ($x = 8{,}060$, $y = 192$). As in many others, the bottom consists of carefully selected sand which imitates the transport observed in the Rangoon estuaries and on the adjacent bars. Starting from the soundings of 1875, the model has succeeded in reproducing the conditions of 1897, 1910 and 1932. The tests have been carried up to and beyond 1982. The model indicates that the deterioration of the Rangoon approaches is unlikely to continue much longer, and Prof. Allen convinces us there is a fair chance that this prediction may come true.

'Continental' practice is gradually developing in the direction of small-scale models: the well-known Mississippi models in Vicksburg have $x = 2{,}000$ and $y = 100$. The Delft laboratory is actually constructing a model of the estuaries and tidal rivers in Holland in which $x = 2{,}400$ and $y = 64$, a vertical exaggeration of 37·5. It is true that these models have fixed bottoms, so that they are not subject to the complication of sand movement, but their scales overlap the recent British ones. Prof. Allen mentions the Great Ouse and Wash model, in which $x = 2{,}500$ and $y = 60$, and in the James Forrest Lecture before the Institution of Civil Engineers which Prof. Allen delivered in May 1947, attention is given to the newly designed model of the Firth of Tay with $x = 1{,}760$ and $y = 144$. In this lecture Prof. Allen explained why British small-scale models with movable bottoms give good results and Continental ones do not. The vertical scale ratio y is limited by the speed V of the current in the channels: from an empirical relation it may be deduced that the upper limit of y is proportional to $V^{3\cdot7}$. I would like to direct attention to the fact that all the British models have to do with parts of the world where high tides and strong tidal currents occur: they would fail if the method were used to reproduce the conditions on the coasts of Denmark or New Jersey or Holland.

The theoretical considerations which underlie the experiments are expounded in the first chapters of the book. Similarity in friction losses is extensively discussed. It is curious that the Bazin formula (which dates from 1897) is taken as a starting point; only little attention is given to the later work of Prandtl, Kármán and their successors, and the interesting investigations at the Imperial College of Science and Technology, London, by Prof. C. M. White and his collaborators are not mentioned at all.

It is to be regretted that in hydraulics so much use is still made of formulæ (like that of Bazin) which describe the results of a number of experiments, but which are not based on adequate theoretical considerations.

For Continental students of hydraulics, the chapters dealing with tidal models are the most interesting ones of the book. They give a survey of how the work in the United Kingdom is done, why it is possible and what its limitations are. Prof. Allen's work will help to create a better mutual understanding between the workers on both sides of the North Sea (and of the Atlantic Ocean).

Other investigations than the tidal ones are not forgotten. The author mentions the paradox that models of small objects such as spillways, sluices and weirs sometimes have to be larger than those of estuaries; the reason for this is explained.

The chapter on waves shows that in several parts of the world much has been done and is being done in order to solve the many problems connected with waves of several kinds. Mutual information is necessary if we want to know more of the impact of breaking waves. The bore or eagre is dealt with, and two beautiful plates give a picture of this phenomenon in the Severn. It is not clear why the hydraulic jump is treated together with the waves: it is no real wave at all, because conditions in it are permanent.

Valuable details of the construction and operation of the models complete this book. We may consider it as a welcome addition to the literature of hydraulics.

J. Th. Thijsse

CEREAL RUSTS

The Nature and Prevention of Cereal Rusts as Exemplified in the Leaf Rust of Wheat

By Dr. K. Starr Chester. (Annales Cryptogamici et Phytopathologici, Vol. 4.) Pp. xvi + 270. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1946.) 5 dollars.

"THE most destructive disease of the world's greatest food crop", is Dr. K. Starr Chester's valuation of *Puccinia triticina*, the orange leaf rust or brown rust of wheat. The reader who, misled by the short title "The Cereal Rusts", turns to this book for a comparative or systematic account of the cereal rusts will be disappointed. He will find instead a valuable monograph on the brown leaf rust of wheat, in which the author summarizes his own researches and gives a comprehensive review of the literature with a bibliography of nearly five hundred titles. In preparing the book the author has translated a number of the major Russian contributions and made them available to other workers by depositing copies in several North American libraries.

Unlike the more familiar black stem rust (*Puccinia graminis*), the brown leaf rust overwinters in most of its geographical range in the mycelial stage on autumn-sown wheat or on volunteer wheat plants. Only in exclusively spring wheat areas, like the Canadian prairies, does the long-distance transport of spores from massive sources on autumn-sown wheat assume a dominant role. Reverse migration from cooler regions has been shown by Chester in the United States and by Mehta in India to recolonize areas where summer temperatures are too high for survival on wheat. Only in the Lake Baikal region

of eastern Siberia does an alternate host regularly play a part in the annual cycle of the rust. *Isopyrum fumarioides*, a common biennial ranunculaceous weed of wheat fields in this area, regularly bears the æcidial stage and is the only means by which the rust survives the winter in this isolated area of wheat cultivation. European species of *Thalictrum* have been infected from wheat artificially, and new physiological races of the rust have been produced on this host by hybridization; but under natural conditions *Thalictrum* is apparently never affected by *P. triticina*. What are the chances of new races developing on *Isopyrum* in eastern Siberia and being borne by uredospore inocula to far distant areas where the brown leaf rust has dispensed with sexual reproduction on its alternate host? Dr. Chester thinks the possibility remote, as the Lake Baikal area is isolated by immense barriers of desert and mountain from other wheat-growing areas. In his account of dissemination the author gives reasons for considering that while dissemination of uredospores may occur over hundreds of miles as in North America and India, nevertheless the Lake Baikal area, Australia and South America are effectively isolated from the rest of the world's wheat-growing areas. Despite this comforting conclusion, *P. triticina* now exists in many physiological races which must have arisen by hybridization on *Isopyrum* or by mutation in the uredinial stage on wheat.

In trying to reduce many of these races to synonymy by introducing the notion of *race-groups*, the author will no doubt provoke criticism. However, this innovation allows him to explain the known reactions of wheat varieties to races of leaf rust in terms of the inheritance of a dozen or fewer hypothetical 'resistance-susceptibility' factors. Physiological races of the rust differ, it is suggested, in their ability to develop in the presence of some combinations of these factors. This leads to an interesting hypothesis as to the nature of the factors involved. "Resistance is commonplace, susceptibility is the rare exception. . . . It is not so much a question of what defences all other plants have that these susceptible varieties lack, as of what positive qualities these varieties have that all other plants lack." The author considers that this role may be filled by certain specific plant proteins, required by the fungus for its metabolism. Of the various kinds of evidence brought forward in support of this hypothesis those based on serological arguments are the least convincing. However, the idea should stimulate experimentation even where it fails to command assent. It falls into line with the concepts of Lwoff developed in his "Évolution physiologique", and with recent work in America and Europe on X-ray induced mutants in moulds and other fungi.

The economic importance of *Puccinia triticina*, according to Dr. Chester, has been unwarrantably under-estimated in face of the greater practical and academic attention focused on the black stem rust, *P. graminis*, with its alternate host on barberry. Extensive data are brought forward to show that, from being looked upon as harmless in Australia and the United States in the early years of this century, and relatively unimportant in the 1930's, brown leaf rust is now regarded as a severely destructive disease on half the wheat acreage of the United States, the U.S.S.R. and China. Attacking the crop earlier than stem rust, *P. triticina* represents a constant drain on the plant, less spectacular than the end-of-season epidemics of stem rust, but every few years reaching disastrous proportions over a large area of North America, as in 1938 when Thatcher wheat, bred for resistance to stem rust but susceptible to brown leaf rust, was destroyed over millions of acres. The importance of *P. triticina* has been confirmed by recent experiments in Canada by Peturson, Newton and Whiteside. In Britain this disease, like the powdery mildew, is common but is usually regarded as of little economic importance. This view appears to be supported by reiteration rather than by experiment, and it may be questioned whether any obviously destructive leaf disease can be dismissed as unimportant without carefully designed experiments in which yields of infected and healthy plots can be compared side by side. The evidence now brought forward should make us think again about *P. triticina*.

In a work of this magnitude, dealing with so many aspects of plant disease, every reader will find details to criticize and points with which he will disagree. The format of this book is larger than that of the earlier volumes in Dr. Frans Verdoorn's *Annals Cryptogamici et Phytopathologici*, and the work may stand awkwardly among its fellows on the library shelf. It is, however, a valuable addition to the literature of plant pathology.

P. H. GREGORY

CONTROL OF THE GERMINAL EPITHELIUM

Contribution to the Knowledge of the Influences of Gonadotrophic and Sex Hormones on the Gonads of Rats

By J. H. Gaarenstroom and S. E. de Jongh. (Monographs on the Progress of Research in Holland during the War.) Pp. viii+164+8 plates. (New York and Amsterdam: Elsevier Publishing Co., Inc., 1946.) 8 fl.

THE idea of publishing a series of monographs on the progress of research in Holland during the recent war is an excellent one. The present volume is the seventh in the series, and consists of two main sections, and an appendix dealing with a number of diverse experimental observations. The first section concerns the hormonal factors on which the maintenance of testicular activity depends. The second deals with the corresponding aspects of ovarian physiology. Both sections are reports of experiments on rats, a fact which has to be borne in mind when generalizing the results. These show that testosterone can maintain the germinal but not the interstitial elements of the testes of rats the pituitaries of which have been removed, and that it therefore has a gonadotrophic function independent of the pituitary. The testicular involution which occurs as a result of œstrogenic stimulation can also be prevented by testosterone, and this Gaarenstroom and de Jongh interpret as being due not to any antagonistic effect of the androgen on the œstrogen, either in the pituitary or the circulation, but to the direct stimulating effect of the androgen on the testis.

This is an interesting conclusion, the more so because it diverges somewhat from previous explanations of the inhibiting influence which androgens have on the results of œstrogenic treatment. From it, and from observations on the differential effects of the two pituitary gonadotrophic hormones, Gaarenstroom and de Jongh build up a general theory of the control of spermatogenesis. Their view is that one pituitary

gonadotrophic fraction stimulates the interstitial cells of the testis to produce androgenic hormone, which in turn activates the spermatogenic cycle of the germinal cells, the initial development of which is under the control of the second pituitary fraction. It is a neat theory, and there is no doubt that it helps to interpret a number of diverse observations. But it does not account for all.

The section on the ovary does not lead to such clear-cut conclusions, and is certainly more controversial. But it, too, is most stimulating to thought, and like the section on the testis, will have to be studied by all workers who are concerned in the study of the development and control of the germ cells.

S. ZUCKERMAN

RESEARCH ON THE TREMATODA

The Trematoda of British Fishes

By Dr. Ben Dawes. (Ray Society, Vol. 131 for the Years 1944 and 1945.) Pp. viii + 364. (London: Bernard Quaritch, Ltd., 1947.)

THIS book is a worthy companion to the same author's book, "The Trematoda" (Cambridge University Press, 1946). The author modestly says that he does not claim to have given an exhaustive account of the trematodes of British fishes, and it has naturally been difficult to decide whether some marine fishes caught off the coasts of the British Isles should be classified as British species or not. New records of species parasitic in particular hosts will certainly be made from time to time as fishes are caught and examined, so that no systematic account written now can hope to be complete. But Dawes has collected, in the 286 pages of classification and systematic descriptions of species in this monograph, the information available at present. To this he adds 26 pages of references to the literature and a list of the British fishes in which the trematodes occur. Both these latter features greatly add to the value of the book. Five chapters give concise accounts of the Platyhelminthes, the three orders of Trematoda and the morphology of the Monogenea, the Aspidogastrea and the Digenea. Many zoologists will find these chapters valuable, quite apart from the systematic details which follow them. A concise account of the Monogenea will be especially useful.

The preparation of this book must have entailed a great deal of labour and care, and it is gratifying to find that the publishers have given it worthy production. It is written in the author's clear and concise style, and the quality of the fifty-one drawings maintains the standard reached in the author's other book mentioned above.

No doubt these two books will stimulate others to take up the many problems which their author outlines. Experimental work is especially needed, and it is likely that, before long, work which is now going on will provide us with a sterile trematode in artificial culture, the study of which will greatly add to our knowledge of the physiology of all the Platyhelminthes. It is not impossible that we shall also learn from this work facts which will lead to a better understanding of the physiology of the Nematoda also.

The beneficent effects of such studies upon the control of diseases of man and animals caused by these organisms would be so considerable that it is to be hoped that experimental biologists will no longer neglect this fascinating field of work. So great, indeed, is the damage done to man and to his food supplies and civilization by the helminths that a strong case could be made out for the organisation of a planned attack upon them. If such an attack were planned, there is no doubt that medical men and veterinarians would heartily co-operate in it; but, before it could succeed, the basic work must be done, and that is work for the experimental biologist who understands the fundamental physiological problems involved and has the experience and training necessary for the study of them.

G. LAPAGE

A COLLECTOR'S TRAIL

The End of the Trail

By Willoughby P. Lowe. Pp. iv+178+18 plates. (Exeter: James Townsend and Sons, Ltd., 1947.) 20s. net.

IN this book, Mr. Willoughby P. Lowe gives some account of his work as a collector for the British Museum (Natural History), which has taken him into many far regions of the world. We say "some account", for Mr. Lowe has spent a life-time in quest of rare creatures and in visiting the most out-of-the-way places. In this by no means bulky volume, which is a successor to an earlier work, "The Trail that is Always New", there are chapters devoted to a winter in Tunisia, no less than four visits to Indo-China, a journey across the Sahara to the Hoggar Mountains, a trip to Tanganyika, collecting in the Ashanti Forests of the Gold Coast, and a visit to the northern territories of the Gold Coast. The reader, greedy for more, feels that these chapters are all too brief; for example, each visit to Indo-China, that ornithological paradise, might well be the subject for a volume to itself.

The facts are related in a style so studiously restrained that it might almost be termed bald, but an occasional descriptive passage gains in impressiveness from its setting. When writing of his work in Tonkin, which was mostly done just north of Hanoi, the capital, he tells us that "... we had special permission to do what we liked. Every day we wandered along the winding paths, cut in the precipitous hillsides where grew magnificent trees, flowering shrubs and ferns. Orchids hung in the shadow of the dark green foliage, and begonias and other beautiful vegetation grew in such utter confusion as to be bewildering. On the ground were fallen fruits, nuts and seeds of every description. Large macaque monkeys made their home along the paths winding in gentle gradient up the mountain slopes and dashed through the tree-tops for safety."

In this wonderful countryside a great variety of life of all kinds was encountered, and a large number of interesting specimens were obtained, including many birds and mammals new to science. The rough list of novelties discovered on this and on other trips which is given at the end of the book is impressive indeed. It embraces many newly described forms of mammals and birds and is an eloquent testimony to the author's hard work as a collector for the Museum. It also gives us a hint, though scarcely more than a hint, of a life not only well spent but also of vast and varied experience; in short, a life to be admired and envied. This book should enthral the young naturalist and set him dreaming of strange creatures in strange lands.

F. PITT

GENETICS AND ALGAL LIFE-HISTORIES

By Dr. KATHLEEN M. DREW
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IN a recent brief review, Barber[1] has directed attention to the need for incorporating results obtained from genetical and cytological studies of the algæ into the general body of genetical science. I am grateful to Prof. Barber for stimulating interest in this field of study, because most genetical work up to the present has been concerned with groups of plants having the Hofmeisterian type of life-history. It is quite unknown to what extent the algæ would lend themselves to extensive genetical investigation and whether data obtained from such experiments would conform to the genetical concepts accepted to-day for the higher plants.

In particular, Barber considered the interpretations of my cytological findings[2,3,4] in *Spermothamnion Turneri* and *Plumaria elegans*. He concludes: (1) that the plants of *S. Turneri* with ninety chromosomes are hexaploid and not triploid and that "it is thus possible that in this species two closed diplobiontic cycles exist"; (2) that the plants with thirty chromosomes are allodiploids; and (3) that the triploid–hexaploid cycle is "fast becoming genetically isolated from its progenitors and will pursue, if it can survive, its own evolutionary pattern". He points out that by not keeping the two cycles distinct, the genetical and evolutionary implications are obscured and "the primary significance of the *completed* sexual cycle is in danger of being overlooked". In *Plumaria elegans* Barber considers that the "genetical situation is entirely analogous to that obtaining in apomictic Angiosperms such as Taraxacum, Hieracium etc., and the asexually propagated bananas and oranges", and that this alga "shows both a normal floridean haploid–diploid diplobiontic cycle (to use the current algological terminology) and a genetically isolated triploid haplobiontic cycle".

With the point of view put forward by Prof. Barber in mind, the available evidence regarding the life-histories of these two floridean algæ are here reconsidered together with the fundamental considerations involved.

While a comparison of the observations in the angiosperms and the red algæ suggests that the fundamental mechanism of chromosome behaviour is the same in both groups, yet certain broad concepts applicable to the angiosperms cannot be transferred without modification to the algæ. The following remarks apply particularly to those red algæ with the *Polysiphonia*-type of life-history. In such algæ the separation of the haploid and diploid phases of the sexual cycle into two physiologically separate entities (omitting any consideration of the cystocarp for the time being) contrasts sharply with the angiosperms, where the haploid is considerably reduced, enclosed in and physiologically dependent on the diploid, which, in fact, exhibits sexual characters.

This somatically separate existence of the two phases is one of the facts which necessitate modification of certain concepts accepted for higher plants. In the first place, the 'progeny' of the diploid phase is the haploid phase and vice versa. While the same is strictly true in the angiosperms, the succeeding diploid phase is referred to as the 'progeny' of the previous diploid. The completion of the gametophyte–sporophyte cycle in these algæ is dependent on the successful establishment, maturation and reproduction of two separate individuals, possibly with different sets of conditioning factors.

Secondly, while the sexual organs are usually restricted to the gametophyte and the tetrasporangia to the sporophyte in such algæ, cases are recorded (especially in the Ceramiales) where, with varying degrees of frequency, both sexual organs and sporangia occur on the same individuals. Whether these individuals are haploid or diploid is unknown except in the cases of *Spermothamnion Turneri*, where cytological evidence shows that the diploid bears both functional diploid sex organs as well as sporangia in which meiosis occurs, and *Nitophyllum punctatum*[5], where sporangia occur on the haploid gametophyte but undergo no reduction division. These examples contrast with the diploid gametophytes of the Bryophyta and Pteridophyta, which usually bear sex organs only. In the latter case the sequence of reproductive phases and the fundamental gametophyte – sporophyte cycle persists and is dependent evidently on factors other than the chromosome number; but in the algæ cited above the gametophyte – sporophyte cycle is either in the process of being established or is upset. If it is upset, it can be considered either an abnormality or an example of the transference of sexuality to the diploid as has happened in the angiosperms. These examples in no way invalidate Sharp's[6] contention that both genetic and non-genetic factors are concerned in the determination of sex as well as of life-histories. The cystocarp of the Florideæ demonstrates that chromosome number is not the predominant factor in determining the sequence of phases, for in some families it has the chromosome number of the gametophyte and in others the chromosome number of the sporophyte.

Thirdly, the formation of triploids and tetraploids becomes possible, and indeed probable, as a result of the occurrence of sex organs on the diploid, as is shown by *S. Turneri*. The fertilization of the carpogonium on a diploid by a haploid spermatium or vice versa and the production of a triploid involves no abnormality in the formation of the gametes. It is comparable to the diploid × tetraploid cross in the higher plants and not with the forms which originate as the result of some abnormality, as in cases where meiosis is nullified or suppressed or syndiploidy occurs. The genetical consequences are different in the two types.

With these general remarks as a background, the evidence available for *S. Turneri* is now summarized. Along the British coast, plants with 30, 60, 90 and 45–50 chromosomes occur. The same is true for the Atlantic coast of North America in the vicinity of Woods Hole, with the exception that there is only indirect evidence of the occurrence of plants with thirty chromosomes. In the earlier work, I regarded thirty chromosomes as the typical haploid chromosome number. Arguing from the genetical point of view Barber suggests that fifteen is the haploid number. The only other species of this genus for which the chromosome number is known is the Pacific species *S. Snyderæ* (*loc. cit.*, ref. 7), and this has thirty-one. At present, therefore, no definite conclusion about the haploid number can be reached.

The British plants of *S. Turneri* with thirty chromosomes bear sex organs and cystocarps and occasionally undivided sporangium mother cells, sometimes healthy, sometimes degenerated. Plants with sixty chromosomes, particularly those in

American waters, are characterized by the occurrence of both functional sex organs and normal tetrasporangia. A normal reduction division precedes the formation of the tetraspores, but no reduction division precedes the formation of the carpogonium. These American plants are known to produce cystocarps, the chromosomes of the divided carpogonium nucleus and the nuclei of the gonimoblast numbering approximately 120. (There are great technical difficulties in obtaining accurate counts of these high numbers; but details of the degree of accuracy reached have been given (*loc. cit.*, ref. 10). Two gonimoblasts (one American, one British) with approximately ninety chromosomes have also been seen and presumably originated from the fusion of sexual cells one with thirty and the other with sixty chromosomes. With the exception of one bearing a degenerated procarpic branch, no reproductive organs had been found on plants known to have ninety chromosomes. The existence of plants with approximately half this chromosome number, that is, 45–50, suggests the occurrence of an irregular meiosis in tetrasporangia on the plants with ninety chromosomes.

In *S. Turneri* certain facts suggest that the production of triploid plants is not necessarily a rare phenomenon; on the contrary, it may be occasional or even common. The facts (1) that triploid plants (with ninety chromosomes) were found on both sides of the Atlantic among the comparatively few plants of known chromosome number, and (2) that, among the still fewer nuclei available in gonimoblasts in a suitable condition for counting, two were triploid support this view. While the evidence suggests the existence of a 45–50 $\rightleftarrows$ 90 cycle, it appears to me from a consensus of evidence that it is not improbable that these plants reproduce most frequently by vegetative means. If there is a tendency for such a cycle to become genetically isolated, the repeated formation of plants with ninety chromosomes must ultimately result in the production of several genetical strains. It is possible that the formation of the triploid is easier to accomplish in the algæ than in the flowering plants, where the tetraploid $\times$ diploid cross is difficult to effect, since environmental conditioning factors such as size relations, endosperm, etc., may be fewer. On this there must be, however, a suspension of judgment until investigations have been extended. It should be noted that if it is accepted that plants with ninety chromosomes are triploid, a difficulty arises in finding a suitable designation for plants with 45–50 chromosomes.

In *Plumaria elegans* sexual plants with thirty-one chromosomes, tetraspore plants with sixty-two and parasporangia-bearing plants with ninety-three occur. The method of origin of the triploid is unknown; but it is possible that it originated in a manner similar to that of *S. Turneri*, that is, by the fusion of a haploid with a diploid gamete. Alternative possibilities that suggest themselves are the fusion of the diploid fusion nucleus with the haploid nucleus of the auxiliary cell or the fusion of the nuclei of two spermatia with the carpogonium nucleus. Unlike the triploid of *S. Turneri* and, in fact, all triploids, that of *P. elegans* has a special type of spore, the parаspore, which reproduces the triploid. Since parasporangia develop only on triploid individuals, it seems permissible to assume they represent a morphogenetic expression of the triploid condition. A comparison of the vegetative propagation of triploid angiosperms with the paraspores of *P. elegans* is no more than a broad biological analogy.

The triploid of *P. elegans* resembles those of angiosperms, however, in having a considerably wider distribution than the haploid and diploid. In this connexion it should be pointed out that the reproduction of the triploid is dependent only on the successful production and germination of the paraspores, whereas the survival of the haploid and diploid is interdependent and depends on the completion of highly specialized reproductive processes. There is nothing to suggest that this triploid is being formed repeatedly, and this being so, it is isolated genetically from the sexual cycle. Tetraspores develop occasionally on this triploid but were too rare for the details of the nuclear divisions to be followed.

Polyploidy, involving specific differences like that occurring in the genera *Chrysanthemum* and *Solanum*, may also occur in the red algæ, and a study of genera such as *Polysiphonia* and *Ceramium* might yield interesting results.

In the algæ, as in the higher plants, it seems possible that autopolyploids may arise by the doubling of the chromosome number in the vegetative nuclei. *Spermothamnion Turneri* has multinucleate cells, and in one of these a nucleus with at least fifty-four chromosomes occurred, all the other nuclei having approximately thirty. Likewise in the polysporangia of *Spermothamnion Snyderæ*[7], nuclei with two or even three multiples of n occurred in the same sporangium. As some nuclei were observed coalescing, this probably provides the explanation of the varied chromosome numbers. Coalescence did not appear to stop meiosis entirely, but the majority of the sporangia on such plants degenerated before maturity.

These observations have all been based on plants growing in Nature, and show the need for more extensive experimental genetical work on the algæ under conditions of culture. A satisfactory culture technique is a preliminary requisite, however, and while some of the simpler forms have been cultured successfully[8] little has been achieved with the more complex marine forms. A preliminary attempt of mine has had some success, and Hassinger is reported by Hartmann[9] to have succeeded in culturing *Callithamnion collymbosum* and to have analysed genetically interesting deviations. A full account of this work is not yet available.

In his article Barber also raised questions of terminology, and I agree that triplo- and polybiontic are unsuitable terms. I[10] have discarded these together with haplo- and diplobiontic and suggested that it would seem more exact to state that the life-history is morphologically mono-, di, tri- or polyphasic and cytologically mono-, di-, tri- or polyphasic. I still adhere to this, these terms being intended to convey a summary of the morphological and cytological facts of each case and nothing more. Such a summary is needed in the algæ where there may be more than one haploid or diploid phases, as in some Ectocarpales and the Florideæ, for example, and where forms such as *S. Turneri* and *P. elegans* occur. The terms haplont, diplont and diplohaplont express the relative length of the n and $2n$ phases.

I have defined life-history[10] as "the observed sequence or sequences of somatic and nuclear phases known for the species under consideration". Life-history, therefore, is not synonymous with completed sexual cycle, which is always a cyclic sequence of two nuclear phases requiring no cytological qualifying term, since it is independent, to a certain extent at any rate, of chromosome number. In *S. Turneri*, for example, it is conceivable, but not proved, that

the life-history includes two or even three completed sexual cycles, the 30 ⇌ 60, 60 ⇌ 120 and 45–50 ⇌ 90. Whether or not they are closed independent cycles cannot be decided on the evidence at present available. Should they be independent, the evolutionary implications would be all the greater. In *P. elegans*, on the other hand, the life-history includes only one completed sexual cycle and the triploid appears to be a 'dead-end' from the evolutionary point of view.

Thus, while agreeing with Prof. Barber up to a point, I have endeavoured to show that life-histories in the algæ are conditioned by non-genetic as well as genetic factors, and that, until more data are available, some restraint in applying genetical concepts based on the higher plants should be exercised.

I am also making a plea for wider and more extensive studies of the life-histories in the various classes of algæ. It is now recognized that while the Hofmeisterian cycle provides an adequate account of the life-history of Bryophyta, Pteridophyta and Spermatophyta, it does not suffice to describe the many types of life-history to be found in the algæ. A knowledge of morphology, physiology and cytology as well as of genetics is necessary for an analysis of the factors conditioning the life-histories in this group of plants and for an understanding of how the gametophyte–sporophyte cycles of the higher plants arose.

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BIOCHEMICAL REACTIONS OF CHEMICAL WARFARE AGENTS

THE true nature of Greek Fire is still wrapped in mystery and it is difficult to decide whether its use constituted chemical warfare. Chemical warfare, as we know it, was employed only in the First World War (1914–18), when mustard gas and phosgene were used and the study of their pathology was commenced. Work on the nature of these agents proceeded slowly from 1920 until 1939, when there was increased interest in poison gas. Since the Second World War ended, some of the work which was carried out for the British and American Governments has been released, or 'declassified' as the Americans say, and been published. The Biochemical Society arranged a symposium held at the London School of Hygiene and Tropical Medicine on some aspects of the biochemistry of these substances on December 13.

In introducing the symposium, Dr. Malcolm Dixon described how much of the biochemical research work was carried out by three extra-mural teams under Prof. R. A. Peters at Oxford, Prof. A. Wormall of St. Bartholomew's Hospital, London, and himself at Cambridge. Similar teams had worked on the problems in the United States. Much of the matter has interest apart from the original purpose of the investigations. In fact, many of the substances developed for use in the event of chemical warfare have found direct peace-time applications. Examples of this include the British anti-lewisite (*B.A.L.*), a general remedy for arsenical poisoning; diisopropylfluorophosphonate (*D.F.P.*), which is being used as a parasympathomimetic drug in treatment of myasthenia gravis; and methyl *bis*(β-chloroethyl)-amine or nitrogen mustard, used in palliation of Hodgkin's disease.

Chemical Reactions of Mustard Gas

Dr. A. G. Ogston gave the first paper of the symposium, dealing with "The Reactions of Mustard Gas in Aqueous Solution". Earlier work, starting with that of R. A. Peters and E. Walker (*Biochem. J.*, **17**, 260; 1923), on the kinetics of the hydrolysis of mustard gas in water had shown that the reactions of hydrolysis and substitution are of the 'SN_1' type described by Ingold. The initial reaction appears to be an activation process of the first order. The activated form can then undergo a number of different second-order reactions with different substances. The secondary reactions compete with each other, so that the final products depend upon the concentrations and velocity constants of reactions of the substituting reagents present. Mustard gas can combine with almost all chemically reactive groups of biological systems. The differences in velocity constants of the activated molecules for reaction with different substances or groups can be expressed by means of competition factors. Thus thiophosphonates which react readily with mustard gas have high competition factors. Substances with high competition factors were tried as therapeutic agents for mustard gas poisoning, but were not very effective. The reaction of mustard gas, ββ-dichloroethyl sulphide, with water leads first to the half-hydrolysis product, β-hydroxyethyl β-chloroethyl sulphide, and then to thiodiglycol. The half-hydrolysis product has only one tenth of the toxicity of mustard gas.

Dr. J. C. Boursnell discussed the reaction of mustard gas with proteins. Early work had shown that mustard gas reacts with horse serum to give a new antigen, that it inactivates enzymes and combines with kerateine to give a product with increased chlorine and sulphur content (R. A. Peters). The free amino-groups of proteins react in alkaline solution; but other groups must also react, as the phenyl-*iso*cyanate derivatives of proteins in which the amino-groups are blocked still combine with vesicants. The protein carboxyl groups also react to give alkali labile derivatives, and nutritional studies with proteins treated with mustard gas have indicated that histidine, lysine, methionine and threonine residues have reacted. Nucleoproteins react to give insoluble derivatives with high sulphur and phosphorus content (I. Berenblum and R. Schoental, *Nature*, **159**, 727; 1947). Studies with mustard gas containing radioactive sulphur (S^{35}) have shown that when the material is injected intravenously into rabbits most of the sulphur is fixed in the lungs and kidney, but pathological studies show that these organs are not seriously damaged by the vesicant.

Effects of Mustard Gas on Enzymes and Tissues

Dr. D. M. Needham described some of the work on the effect of mustard gas on enzymes and tissues. A brief account of this aspect of the subject has already appeared in *Nature* (M. Dixon and D. M. Needham, *Nature*, **158**, 432; 1946). Of a large number of enzymes subjected to the action of mustard gas in low concentrations, only the phosphokinases and some proteinases are markedly

inhibited. Of the phosphokinases, hexokinase was the first to be examined, and it is probably due to inhibition of this enzyme and deuterohexokinase that the glycolysis of tissues is inhibited by vesicants. Hexokinase is a sulphydryl enzyme, but the inactivation by mustard gas appears to be due to reaction with other groups than the sulphydryl group. When hexokinase is inactivated, five or six molecules of mustard gas react with each molecule of the enzyme. Hexokinase is inhibited in the skin of animals treated with mustard gas, and this effect may be the fundamental cause of the pathological changes. Creatine phosphokinase is even more sensitive to mustard gas when tested *in vitro* but is not inhibited in tissues of animals treated with the vesicant.

British Anti-Lewisite

The development of British anti-lewisite (*B.A.L.*), which is a product of the Biochemical Laboratory at Oxford, was outlined by Dr. R. H. S. Thompson (cf. R. A. Peters, L. A. Stocken and R. H. S. Thompson, *Nature*, **156**, 616; 1945). Early work carried out at Oxford (E. Walker, *Biochem. J.*, **22**, 292; 1928) and in the United States showed that arsenicals reacted readily with SH groups of glutathione or of proteins. Sodium arsenite and the arsenical vesicant, lewisite, poison the pyruvic acid oxidase system of brain tissue, and the blood of animals poisoned with arsenicals has a high concentration of pyruvate analogous to that occurring in thiamine deficiency.

The pyruvic oxidase system was used as an *in vitro* test for substances which would neutralize the toxicity of arsenicals. Study of the reaction of arsenicals with keratеine showed that each atom of arsenic reacted with two SH groups of the protein. Monothiol compounds had no effect in neutralizing arsenical poisoning, but a number of dithiols were effective. Of the latter, 2 : 3-dimercaptopropanol was the most suitable, and proved to be an efficient antidote both when tested *in vitro* with the pyruvate oxidase system and *in vivo* against the vesicant action of lewisite on human skin and against the toxic action in animals and men. This compound was called 'British Anti-Lewisite' (*B.A.L.*), and it is now used clinically in treatment of arsenical dermatitis. Dr. Thompson suggested that sulphydryl enzymes might be divided into two classes: (*a*) those which are protected by monothiols, as are choline esterase and hexokinase; and (*b*) those which require dithiols, as do pyrophosphatase and pyruvate oxidase. It is possible that members of the second class require two thiol groups in close proximity for their action, whereas those of the first group need only one thiol group.

Lachrymators

Dr. M. Dixon, in describing the reactions of lachrymators with enzymes and proteins, showed how most lachrymators fall into three classes: the active ('positive') halogen compounds, unsaturated compounds and arsenicals. All lachrymators of these classes poison sulphydryl enzymes, and this suggested that the lachrymators react with sulphydryl residues. Many different experiments showed this to be the case, and the lachrymators are specific reagents for identifying sulphydryl enzymes. The active halogen-containing lachrymators can be used for the manometric estimation of sulphydryl groups as they react rapidly, giving acid proportional to the sulphydryl groups present.

Alkyl Fluorophosphonates

The alkyl fluorophosphonates are highly toxic substances, first made by Dr. B. C. Saunders and shown by Prof. E. D. Adrian and Dr. W. Feldberg and by Dr. Mackworth to be inhibitors of choline esterase. Dr. E. C. Webb discussed the nature of this inhibition, which is non-competitive and not reversed by dialysis. Eserine also inhibits choline esterase, but such inhibition is competitive (being reduced by increase in concentration of the substrate, acetylcholine) and reversible on dialysis. These new compounds are very potent. Thus horse serum choline esterase (that is, pseudo-choline esterase) is inhibited to the extent of 50 per cent by $1{\cdot}3 \times 10^{-9}$ *M* di*iso*propylfluorophosphonate. Such fluorophosphonates poison other esterases, such as liver esterase. In addition to the fluorophosphonates, hexaethyltetraphosphate and tetraethylpyrophosphate, which were introduced as insecticides, have been found to be extremely potent poisons of choline esterase.

'Nitrogen Mustards'

The pharmacology of the chloroethylamines, to which class the 'nitrogen mustards' belong, was described by Dr. E. Boyland. The nitrogenous vesicants, which are poly(β-chloroethyl)amines, have many properties similar to mustard gas. Study of these substances led to the discovery of interesting pharmacological properties in related compounds. Dimethyl-β-chloroethylamine, on injection into animals, causes prolonged partial paralysis, so that treated mice have the appearance of waltzing mice. Dibenzyl-β-chloroethylamine (known as 'dibenamine') antagonizes and reverses the action of adrenaline on the blood pressure. The alkyl *bis* (β-chloroethyl)-amines are very toxic substances and potent vesicants. The best known of these is methyl *bis* (β-chloroethyl)-amine (HN2). These chloroethylamines are very reactive and combine with many tissue constituents and with water to produce a series of products. One of the hydrolysis products, which has been identified as β-hydroxyethyl methyl ethyleneimonium chloride, causes partial paralysis and rapid death of mice, with convulsions. The poly(β-chloroethyl)amines are also of interest because, like mustard gas, they are radiomimetic poisons—many of their effects resemble those produced by ionizing radiations. Such effects include vesication, death following hæmoconcentration due to loss of fluid by diarrhœa and vomiting, particularly severe damage to the intestinal tract, bone marrow and lymphoid tissue, resulting in reductions in the concentrations of circulating leucocytes and platelets. Both kinds of agent have similar effects on cell nuclei, causing stickiness of nuclei and chromosome breaks. They have been shown to induce mutations in *Drosophila*, *Neurospora* and *Escherichia coli*. Both the vesicants and radioactive material cause greying of the hair of coloured mice without preventing the growth of the hair. The poly(β-chloroethyl)amines have been used clinically as alternatives to radiotherapy in the treatment of leukæmia, Hodgkin's disease and bronchogenic carcinoma. One of the drawbacks to the treatment is the nausea and vomiting caused, which are similar to radiation sickness. The similarity in effects of vesicants and radiations suggests that the study of the action of vesicants may lead to increased knowledge of the mechanism of the biological action of radiations.

At the conclusion of the symposium, Prof. R. A. Peters expressed the view that the investigations on war gases which had been started should be carried to their conclusion. He thought that biochemistry owed a debt to the Ministry of Supply, and particularly to Mr. J. Davidson Pratt and Mr. L. T. D. Williams, for their encouragement of biochemical investigations into these particular war-time projects. Much of the research has given us knowledge which is of both academic interest and practical value in peace-time.

E. BOYLAND

REPRODUCTION OF PHOTOGRAPHICALLY RECORDED OSCILLOGRAPH SIGNALS

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THE practice of recording the secular variation of an E.M.F. signal, representing some physical variable, by photographing an oscillograph screen on a moving film, is now common to almost every branch of applied science; in the past decade, many thousands of feet of film have been so used in the study of an ever-increasing variety of problems. Doubtless the versatility of the cathode ray oscilloscope is at the same time the *raison d'être* and the *sine qua non* for this ubiquity, not the least of its good qualities being its robustness and ability to continue operating under conditions which would preclude other methods.

Frequently it is required to analyse the oscillograph film record in some detail: the peak, mean, or root mean square values of the wave may be required, the Fourier components, or the value of certain ordinates and their corresponding abscissæ. Often, too, the analysis is of such a nature that it could most readily be carried out by electronic methods, as when the operation to be performed is a function of a differential operator. In view of these considerations, especially in the study of mechanical vibrations, it became evident that a means of reconverting the oscillograph record into an E.M.F. signal would be of value, and accordingly experiments were undertaken which resulted in the production of the curve follower described here.

The development of the instrument was both a test of the applicability of the principle employed to the general requirements enumerated above, and an attempt to meet a specialized need for a means of reproducing certain records containing frequencies from zero to about 200 c./s. Before the work was commenced, however, careful consideration was given to the possibility of employing one or other of the conventional means of acoustic reproduction (if necessary, using a frequency modulated system), such as sound-on-film or disk, or magnetic tape, and in this connexion special importance was attached to the following factors: the size and ruggedness of the recording equipment; its ability to operate in the presence of mechanical vibrations of acceleration magnitude several times that of gravity; its frequency response; and the reliability with which the original signal could be systematically and continuously reproduced. Direct reproduction from an oscillograph record offered a number of advantages: the recording apparatus is readily portable and insensitive to mechanical vibrations, consisting only of the standard laboratory type of oscilloscope and camera; and, moreover, visual observation of the signal can be carried out directly both from the record or from the tube screen. The frequency response of the reproducing equipment is constant down to D.C., a reading of the ordinate being obtained on a voltmeter plugged into the output whether the film is or is not in motion. The output-level is high without amplification (of the order of tens of volts) and is insensitive to changes in the characteristics of components or to the contrast or gradation of the film; and, moreover, it was thought that the method would be of value as an automatic curve follower for feeding analysers with any curve from which a photographic copy or other suitable black-and-white transparency could be made.

The film record, consisting of a clear line trace upon a dark ground, is mounted so as to pass between a lens and a photo-electric cell, while before the lens with its screen focused on the film is a cathode ray tube. A linear 'time-base' moves the cathode ray spot across the screen so that its image scans the film along the ordinate until it reaches the trace, at which instant the sudden change in light entering the photocell produces a pulse which is used to trigger the 'time-base', causing it to restart its sweep from the edge of the record. This process is repeated several thousand times a second, so that the mean voltage on the cathode ray tube deflector plates is a measure of the distance the spot moves from the edge of the record, that is, of the ordinate. Thus, by filtering out the time-base frequency from the sweep voltage, a signal proportional to the ordinate is obtained, and providing the frequency of variation of the signal is less than the scanning frequency by a factor greater than about 5, there is a faithful reproduction of the record.

In the initial experiments all the electronic circuits apart from the photocell were provided by a commercial type of laboratory oscilloscope (the 4-inch double-beam instrument made by Messrs. Cossor, Ltd.), the sweep voltage being produced by the oscilloscope's own 'time-base', while the amplification of the synchronizing pulse was performed by the deflexion amplifiers of the same instrument, the film being repassed through the camera that was used to make the record after it had been modified to take a photo-electric cell behind the film.

As a result of the success of these experiments and in view of the mechanical and electrical simplicity of the method, it was decided to build the instrument shown in Fig. 1, capable of reproducing continuously a loop recording carried on an aluminium drum 10 ft. in circumference. This form of construction was chosen because it completely eliminates wear on the film, and also with the view of using the instrument as the scanning part of an analyser of the type developed by Barber and his colleagues at the Admiralty Research Laboratories[1]. This analyser employs a varying width black-and-white record on photographic paper, mounted on a drum which revolves at a slowly decreasing speed. As the speed falls, each harmonic of the record is in turn brought into resonance with a vibrating galvanometer, from which a signal is obtained providing the Fourier amplitude analysis of the record. The possibility of using such an analyser directly on an oscillograph record is a considerable simplification, and at the

* Formerly at Admiralty Mining Establishment, Havant.

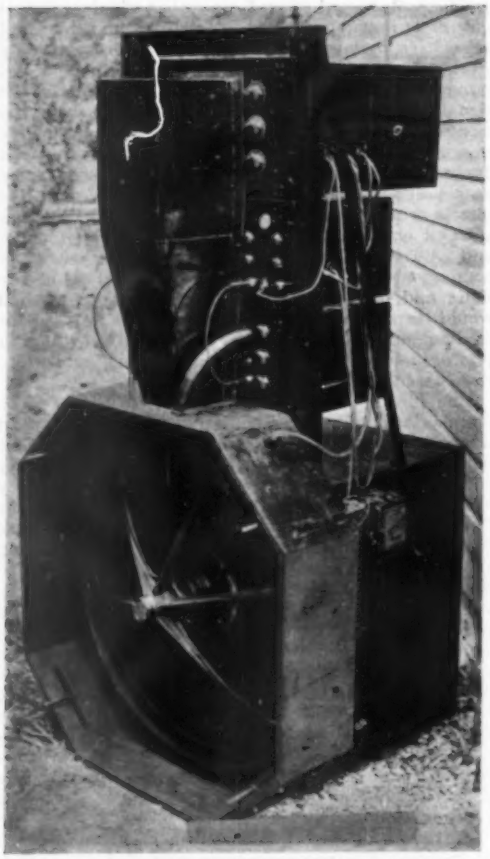


Fig. 1. CURVE FOLLOWER. THE COMPLETE INSTRUMENT IS 5 FT. HIGH

same time makes it possible to deal with record samples containing a harmonic range some ten times wider than was previously possible. The drum of the curve follower is the only part of the instrument which was required to be made with a high degree of precision, as any axial motion of the film would introduce a spurious signal. It would not, however, be difficult to remove the need for precision here by arranging the scan to start from some fixed line on the film, instead of some fixed voltage on the deflector plates.

The basic requirements for faithful reproduction are that there shall be an adequate rate of scan to deal with the highest frequency present in the record; that synchronization of the sweep occur reliably; that the deflexion voltage after filtering be accurately proportional to the peak deflexion voltage before filtering; and that the record be clearly defined and free from blemishes. There are two factors likely to influence the highest frequency which can be satisfactorily reproduced, assuming a record of sufficient contrast and resolution has been obtained. First, the geometry of the trace and scanning spot, as determined by the film velocity, trace thickness, and electrical and optical focus of the spot must be taken into consideration; and secondly, the frequency response of the photocell and electrical circuits is important.

It is not difficult, using ordinary laboratory oscilloscopes and cameras, to produce records in which the trace is 0·005 in. wide, and a scanning spot of the same size can readily be obtained, so that it should be possible to reproduce wave-lengths on the film of 0·05 in. with an error in amplitude of about 1 per cent. Using a film speed of 18 in./sec., this would give an upper frequency limit of 360 c./s. (At the same film-speed, twice this frequency could theoretically be attained with an error in magnitude of about 12 per cent, and even this could be reduced at the cost of some slight harmonic distortion by shaping the response of the output filter.) In the present apparatus a variable film-speed up to 18 in./sec. is employed, and since, as has already been mentioned, the frequency band of interest is 0–200 c./s., there is an ample margin of response.

On considering the question of the frequency response of the electronic components, it is clear that the photocell and circuits have to deal with a pulse lasting for a small fraction of the scanning period, which itself is some ten times shorter than the period of the maximum frequency to be reproduced. This gives a pulse of about 10–15 microsec. (Fig. 2), which presents no problem so far as amplification is concerned (a straight two-stage resistance-condenser coupled amplifier is employed) but does make it necessary to give careful consideration to the photocell and cathode ray tube screen.

Let J be the luminous power from the scanning spot reaching the photocell through a clear part of the record, β the opacity of the dark part of the record, c the velocity of the scanning spot at the film, d the trace width, and T the decay constant of the oscilloscope's screen luminescence (assumed exponential). Then the change in luminous power reaching the photocell when the light spot reaches the trace is given approximately by:

$$\Delta J = \pm(1 - 1/\beta)\{1 - \exp(-d/cT)\}J,$$

the positive sign corresponding to a clear trace on a dark ground, and the negative sign to the reverse.

T is large compared with d/c, so that ΔJ decreases rapidly as the scanning speed increases, and eventually becomes swamped by the shot noise from the photocell. In the early experiments a gas-filled cell was used, but the reproduction of the higher frequencies makes a hard cell more suitable, especially if it is of the electron multiplier type. If such a cell is used (as is the case here) the root mean square shot noise current is proportional to the square root of the mean cell current.

To prevent spurious synchronization of the sweep, the shot noise and hence the mean cell current (while the spot is not on the trace) must be kept at a minimum, and for this reason the transparent trace-on-a-dark-ground type of record is employed. This gives a shot noise $1/\sqrt{\beta}$ times that due to the reverse

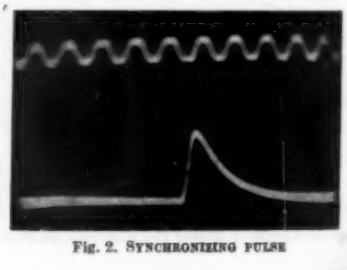


Fig. 2. SYNCHRONIZING PULSE

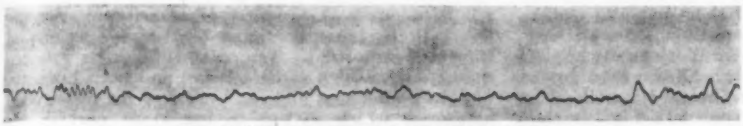


Fig. 3. CONTACT PRINT FROM SPECIMEN RECORD

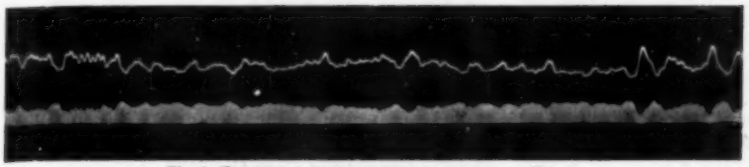


Fig. 4. ELECTRICAL REPRODUCTION OF RECORD IN FIG. 3

type, and at the same time reduces by the square of this factor noise due to modulation of the spot brilliance such as may occur if the oscillograph screen is not of uniform sensitivity. Reliable synchronization has also been assisted by thoroughly smoothing the voltage supplies to those electrodes affecting spot brilliance; by using the first tube of the amplifier as a short time-constant electrometer and so partially integrating the pulse current; and by introducing a small diode which rejects signals in the synchronizing circuit below a certain amplitude.

A fairly high-voltage cathode ray tube has been employed, as this gives a longer screen life than would a low-voltage tube operating at the same brilliance. The lens used with this tube is an f 1·0 coated anastigmat giving an optical reduction to 1/10.

The final output signal of the curve follower is obtained by feeding the 4 kc./s. scanning voltage through a low-pass filter preceded and terminated by cathode follower circuits, and having a cut-off at about 1 kc./s. In order that the voltage so obtained may be a faithful reproduction of the amplitude envelope of the scanning voltage, it is necessary for the latter to be linear (with respect to time) and for flyback and restart to be relatively instantaneous. For this reason O. S. Puckle's hard-valve time-base circuit[2] has been employed, the only modification being the addition of a diode to limit the flyback and so to ensure that the scan always restarts at the same voltage irrespective of the previous ordinate scanned. This was found useful in practice, though a careful setting of the time-constants of the circuits might make it unnecessary.

A microammeter reading the photocell current and a small monitoring oscilloscope have been provided to assist in setting the controls.

It will be appreciated that the absence of any requirement for a high-gain linear amplifier and the fact that the only voltage to which the output-level is sensitive is the accelerating voltage on the cathode ray tube are valuable factors, as they simplify greatly the problem of stabilization. Further, the photographic technique presents no difficulties and requires no specialized equipment, since it is only necessary to provide sufficient contrast and adequate transparency of the trace; gradation and the actual value of the contrast being of no importance. A reversal process must, of course, be employed. At the present time Ilford *5G*91 film is used, developed in 1*D*.33 to which a small quantity of formaldehyde has been added as hardener, potassium dichromate and sulphuric acid being used for bleaching prior to redevelopment in the same developer. Initial development is carried out until there is considerable fogging, as this ensures a maximum transparency of the trace while only slightly decreasing the density of the blacks.

When the instrument is correctly adjusted, the background noise voltage, as determined by measuring the signal when the instrument was scanning a straight line trace, is about 0·5 per cent of the maximum voltage output. An idea of the performance can be gained from Figs. 3 and 4. The upper trace of Fig. 4 is an oscillograph record of the output of the curve follower when scanning the record of which Fig. 3 is a contact print. The lower trace of Fig. 4 is a record of the unfiltered scanning voltage (the phase reversal being introduced by the oscillograph used to make records).

Thanks are due to the Board of Admiralty for permission to publish this article.

[1] Barber, Ursel, Darbyshire and Tucker, *Nature*, **158**, 329 (1946).
[2] Puckle, O. S., *J. Televis. Soc.*, **2**, No. 5 (1936).

OBITUARIES

Prof. Theodore D. A. Cockerell

PROF. THEODORE D. A. COCKERELL, the distinguished naturalist and moralist, died suddenly at San Diego, California, on January 26 at the age of eighty-one.

He was born on August 22, 1866, the eldest of the six children of Sydney J. Cockerell, of Beckenham, Kent; a younger brother, now Sir Sydney Cockerell, was for many years director of the Fitzwilliam Museum, Cambridge. Threatened with tuberculosis at the age of twenty-one, he went to live in the mountains of Colorado and thrived there. Later he held appointments at the Public Museum, Kingston, Jamaica, at the New Mexico Agricultural College, and finally back again at Colorado as professor of zoology at the University of Colorado at Boulder, where he spent the greater part of his life.

Cockerell was a keen naturalist from his earliest days, and started publishing his first observations at the age of twelve. He travelled in all the continents of the world, making collections in Hawaii, Japan, Siberia, Australia, Madeira, Morocco, the Belgian Congo, Honduras and Argentine. So recently as 1946 he flew with his wife to Honduras, intent on exploring the little-known fauna and flora of that country, and he discovered there many previously unknown animals.

He was a prolific and versatile writer on any aspect of natural history, education and ethics that crossed his path. He opened new fields for research on such subjects as snails, scale insects, fossil insects, the genetics of sunflowers, the scales of fishes, the anatomy of rodents and the classification of bees. Working early under the shadow of imminent death, he acquired the habit of hurrying his ideas and observations into print as soon as he could. The habit persisted throughout his long life, so that almost all his

work appeared in the form of short papers. On the insects alone he published more than 1,200 of these. He proposed 5,500 new names for species and varieties of animals of all classes, though he worked most at the bees as he loved them the best. His collections he gave away to public museums as fast as they accumulated; 13,700 specimens of insects, many of them unique types, he gave to the British Museum (Natural History).

A final appraisal of this huge amount of work must, of course, await the verdict of future investigators. Cockerell worked easily and incessantly, and he inspired generations of American students with his quiet enthusiasm for natural history, his youthful and modern outlook, and his simple goodness; he was beloved by all who knew him.

He was twice married: first to Anne Fenn, daughter of Manville Fenn, the novelist, and afterwards to Willmatt Porter, an American devoted to the study of natural history, who survives him.

ROBERT B. BENSON

Prof. R. E. Liesegang

BY the death of Raphael Edward Liesegang on November 13, at Homburg vor der Hoehe, in his seventy-eighth year, colloid science loses one of its most cultured members.

The early years of the present century witnessed the gradual transition of interest in colloid science from its qualitative and descriptive to its quantitative and mathematical aspects. A few notable workers, now a rapidly diminishing number, made their contributions over this period of transition. Among these, R. E. Liesegang must be regarded as one of the most important. Temperamentally, he was endowed with a high artistic sense, and both his command of languages and the purity of his prose were attributes which played an important part in his scientific work.

His name will always be associated with that interesting phenomenon of periodic precipitation in gels, resulting in the formation of 'Liesegang rings'. The beautiful structures in banded agates can readily be reproduced in the laboratory by diffusion of electrolytes into gels containing suitable precipitants. Many claims resting, however, on somewhat more slender experimental evidence have also been made to interpret several different types of lamellar structures in biological material in terms of Liesegang precipitation.

Liesegang made notable contributions to our knowledge of the sensitiveness of photographic emulsions to light, and must be regarded as one of the pioneers in the fields of colour photography and television. Investigators interested in the early development of methods owe a great debt to Liesegang for his "Kolloidchemische Technologie". ERIC K. RIDEAL

WE regret to announce the following deaths:

Dr. C. W. Kimmins, for many years chief inspector of the Education Department of the London County Council, on January 12, aged ninety-one.

Prof. Burton E. Livingston, emeritus professor of plant physiology, Johns Hopkins University, aged seventy-two.

NEWS and VIEWS

British Hydromechanics Research Association

THE design and manufacture of hydraulic machinery is one of the oldest and most important branches of mechanical engineering, including, as it does, water turbines for power production, pumps of all kinds for water and other liquids, hydraulic presses for various purposes and a great variety of other machines and equipment associated with nearly all forms of industrial activity. At the present time, British manufacturers of such machinery are making a full and valuable contribution to the export drive. But the industry is a competitive one, and it is welcome news that despite their present preoccupations, the leading manufacturers have realized that it is only by continuous co-operative research and development that these activities can be maintained and extended, and have formed the British Hydromechanics Research Association for this purpose. The president of the Association is Sir John Anderson, and it is a good sign that the Council, in addition to representatives of the leading manufacturers, includes representatives of large users of hydraulic machinery.

The director of the new Association will be Mr. L. E. Prosser, who has had many years experience of research in basic and applied fluid mechanics at the National Physical Laboratory, and of the application of the results of such researches to the solution of important problems encountered in engineering practice. The Association will work in close co-operation with the new Mechanical Engineering Research Organisation of the Department of Scientific and Industrial Research, which is planning to erect a well-equipped hydraulic machinery research laboratory as one of its most important activities in the general development of mechanical engineering science and its application to useful purposes. It has been said with some justification that whereas Great Britain has taken a leading part in the development and application of research in aerodynamics, the sister science of hydromechanics has been neglected. These new activities should go a long way to remedy this discrepancy, with resulting advantages both to manufacturers and to users of hydraulic machinery.

Research in Central Africa: Dr. J. E. Keyston

SUPPORT was forthcoming from all branches of scientific opinion for proposals put forward in 1946 at the Royal Society Empire Scientific Conference that research in Africa, south of the equator, should be planned and organised on a regional basis. Even before the Conference, the three Central African territories of Southern Rhodesia, Northern Rhodesia and Nyasaland were contemplating arrangements for a joint attack upon the research problems of their own sub-region of Africa, and for collaboration with the research organisations in the neighbouring territories of East Africa and the Union of South Africa. The Central African Council, which is a consultative assembly of representatives of the three Central African countries, has given effect to proposals made

by a Special Committee on Joint Research set up at the end of 1945, by appointing a 'research secretary' whose first duty will be to survey the research facilities available in the Central African, East African and South African territories, to report on any additional facilities required in Central Africa and on the relations to be established between research work and workers in Central Africa and in other countries. This survey is expected to lead to recommendations regarding the nature, priority and future organisation of research in Central Africa.

Dr. J. E. Keyston, who arrived at Salisbury, Southern Rhodesia, in November 1947 to take up the appointment of research secretary, graduated with first-class honours in physics at University College, Nottingham, and thereafter pursued research on gas discharges and on the hyperfine structure of spectral lines at Nottingham, the Electrical Laboratory, Oxford, and the Einstein Laboratory, Potsdam. During 1933–37 he held a scientific appointment in industry and then joined the staff of the Admiralty Research Laboratory. Since the end of 1938 Dr. Keyston has served in the Admiralty headquarters department of scientific research, where he became assistant director of scientific research in 1943 and later deputy director of research programmes and planning. His wide experience of research administration and, in particular, his record in promoting close and friendly liaison between the Admiralty and other research bodies, including the research organisations of the Dominions and the United States, appear well matched to the duties he is to undertake for Central African research.

Beilby Memorial Awards

AWARDS are made annually from the Sir George Beilby Memorial Fund to British investigators in science as a mark of appreciation of distinguished work, particularly in such fields as fuel economy, chemical engineering and metallurgy, in which Sir George Beilby's special interests lay, and generally as an encouragement to younger men. Owing to the War, no awards were made during 1941–46 inclusive; but at a recent meeting of the administrators it was decided to make awards for 1947 to Dr. G. V. Raynor, for his researches on the constitution of alloy systems; and to Dr. G. R. Rigby, for his researches on refractory materials.

Dr. G. V. Raynor was educated at Nottingham High School and Keble College, Oxford. He obtained a first-class in the Honours School of Natural Science (Chemistry) in 1936 and, after a year of postgraduate research on copper alloys in the Inorganic Chemistry Laboratory of the University of Oxford under Dr. W. Hume-Rothery, became research assistant to the latter for work on factors affecting the formation of magnesium alloys. Following election to a senior research award of the Department of Scientific and Industrial Research, he continued investigations on magnesium alloys and obtained the degree of D.Phil. in 1939. During the war period Dr. Raynor was concerned, in association with Dr. Hume-Rothery and others, with work on the constitution of certain steels and aluminium alloys on behalf of the Service Ministries. Early in 1945 he entered the Metallurgy Department of the University of Birmingham as research fellow and became reader in theoretical metallurgy two years later. His work in Birmingham has been directed towards a better understanding of the theory of alloy formation, with particular reference to the behaviour of the transitional metals, and the factors governing equilibrium relations in ternary alloys.

Dr. G. R. Rigby was born at Stoke-on-Trent and, after receiving his general education at Hanley High School, studied chemistry at the North Staffordshire Technical College. In 1928 he was awarded a Royal Scholarship and proceeded to the Imperial College of Science and Technology, London, where he obtained two years later the A.R.C.Sc. diploma and the B.Sc. degree of the University of London with first-class honours. He spent the next two years in the Physical Chemistry Department of the College engaged in research under the late Prof. J. C. Philip on the measurement of electrical charges at gas–liquid interfaces, and was awarded the Ph.D. degree for a thesis on this subject. His appointment in 1932 to the staff of the British Refractories Research Association brought him into touch again with the Staffordshire pottery industry. Initially under the direction of the late Dr. J. W. Mellor and, since 1937, of Mr. A. T. Green, Dr. Rigby has been engaged continuously on a wide range of research work on refractory materials for the pottery industry, and latterly for the iron and steel industry.

Road Research

FOR three months during 1946, Dr. W. H. Glanville, director of the Road Research Laboratory of the Department of Scientific and Industrial Research, visited North America to study the progress made there in applying the results of research to road construction and safety. A report of the visit has now been published as "Road Research Technical Paper No. 7" (London: H.M. Stationery Office, 1947. 1*s.* 6*d.* net). The Road Research Laboratory was engaged in important work during the War, which necessarily hindered the development of the programme of road research in Britain, particularly as regards road safety and the construction of concrete roads. The main purpose of the American visit was to see the progress made in these directions. Problems relating to the serious matter of road safety are being actively investigated in many parts of the United States. As in Britain, the problem is being tackled under three main headings: education, engineering and enforcement. It is interesting to note that while improvements in vehicles in aspects concerning safety are largely in the hands of the motor industry, concerted action is being taken, and the Automobile Manufacturers Association has formed an Engineering Liaison Committee which, by the pooling of patents and ideas, has produced a standard headlamp now fitted to all new American cars. The Committee is also at work on the problem of dazzle, which with the imposition of a partial black-out in towns in Britain has taken on a new urgency. Successful tests have been carried out by the General Electric Co. on the use of headlights emitting polarized beams; with the use of a 'Polaroid' visor it is possible to pass a car with its headlights full on with no discomfort although the road around appears well illuminated. The technical problem appears to be solved; but the difficulties associated with transition from plain to polarized lights remain. In America, as in Great Britain, the design of the structure of the carriageway is based more on the result of experience than on scientific principles. However, much experimental work is in hand which will enable theories to be tested. As an appendix to the report, extracts are given from the programme of the Highway Safety Conference held in Washington, May 1946.

Survey of Svalbard

THE Norwegian Svalbard department (Norges Svalbard-og-Ishavs-undersökelser), as can be judged from the report of its activities 1936–44 (*Skrifter*, Nr. 88. Oslo: Jacob Dybwad, 1945. 6.50 kr.), was busy during the period of enemy occupation, although the last expedition to Svalbard was in 1939 and to East Greenland in 1941. The report contains full accounts of these expeditions and of the useful work done in Oslo in compiling various Svalbard maps, on the bibliography of Norwegian polar literature and the exhaustive report on Svalbard place names. "The Survey of Björnöya" (Bear Island), completed between 1922 and 1931, forms a separate publication with full details of the work and a revised edition of the contoured map of the island on a scale of 1 to 25,000. This is printed in brown, blue and black. Small reproductions of some of the earlier sketch maps of the island are also given. This monograph, together with that of G. Horn and A. K. Orvin on the geology and history of the island (*Skrifter*, Nr. 15. Oslo, 1928) with its geological map, form an exhaustive survey of the island, which is now one of the most carefully surveyed areas in polar regions.

SVALBARD includes all the islands over which Norway acquired sovereignty by the treaty of 1920. These islands lie between lat. 74° and 81° N., and long. 10° and 35° E. Included are Spitsbergen, Bjørnøya, Hopen, Kong Karls Land and Kvitøya. The Svalbard Archipelago has been visited by western Europeans since A.D. 1194, and it is generally agreed that the Svalbard mentioned in the Icelandic annals refers to these islands. In 1596 the Dutch arrived while trying to discover the North-East Passage, and from the start of the seventeenth century there was much Dutch and English whaling activity. From about 1720–1852, Russian trappers used to winter there and have left traces of their visits. Since then there have been not a few purely scientific expeditions to the region. A list of place names has now been issued (Skrifter om Svalbard og Ishavet, Nr. 80. Pp. 540. Oslo: Jacob Dybwad, 1942. 50 kr.). The names are arranged alphabetically, and bibliography, indexes and a map are included. The committee responsible is to be congratulated on a notable piece of work. It is written in English.

Carnegie United Kingdom Trust

THE thirty-third annual report of the Carnegie United Kingdom Trust, to which are appended the accounts for the year ending December 31, 1946, records the progress made during the first year's execution of the plans for the current quinquennium. The principal allocations for the quinquennium opening on January 1, 1946, are £150,000 for music and drama; £100,000 for village halls; £150,000 for the Bureau of Current Affairs; £30,000 for museum services; £25,000 for Young Farmers' Clubs, and £40,000 for youth hostels. The Trust is constituting a small committee to examine the recommendation in Miss E. Younghusband's report on the training of social workers, for the establishment, in association with an appropriate university, of a Carnegie School of Social Work. A new grant has been promised to the National Federation of Women's Institutes in aid of the foundation of a residential centre, at Marcham Park, near Abingdon, to which countrywomen may resort to study problems affecting rural life and for suitable courses of instruction. A grant up to £750 has been promised to enable the Central Landowners' Association, together with other bodies concerned with the preservation of the countryside, to promote a competition designed to encourage the study of village planning.

Funds are being made immediately available for museum services for three main purposes: the supply of expert reports to museums which may wish to consider possible lines of development; the provision of grants to museums already able to carry out approved schemes of reorganisation; and the training of museum staffs. The Trust has continued to meet the whole cost of maintaining the Irish and Scottish Central Libraries for Students, and, in addition to renewing its grant in aid of the National Central Library, has made exceptional grants of £400 to Rutland and £1,500 to Argyll for the establishment of a county library service. A further grant of £6,000 has been promised to the Council for the Promotion of Field Studies for the adaptation and equipment of Flatford Mill as a pioneer field centre. Grants of £2,500 to the Highland and Islands Film Guild for the provision of a mobile film service in two of the crofting counties of Scotland, a capital grant of £2,500 for the adaptation and equipment of Bisham Abbey as a national recreation centre by the Central Council of Physical Recreation, and a grant of up to £1,000 a year for five years for an inquiry into certain aspects of juvenile delinquency to be conducted at the Philanthropic Society's School, Redhill, are also recorded.

Earthquake in the Philippines

ON January 25, a series of some eleven earthquake shocks shook the central Philippine Islands for about four hours. The sugar-growing island of Panay, approximately 285 miles south-west of Manila, was most affected, and the islands of Negros, Cebu, Leyte and Marinduque, all densely populated, were also shaken. The six-storied campanile of the ancient Jaro cathedral collapsed and some fissures caused by the earthquake were more than 100 yards long. Altogether damage was caused to the extent of about £100,000, and at least twenty-seven deaths and many injuries were occasioned by the shock. The earthquake was recorded at observatories throughout the world as the greatest since the Japanese earthquake of December 21, 1946.

The Philippine Islands are definitely in a seismic zone, small shocks occurring there frequently. Considerable earthquakes are reported from time to time, and an extensive catalogue of these, from the Manila earthquake of 1589 to the Butuan earthquake of December 26, 1899, has been compiled by the Rev. William C. Repetti, *S.J.* Destructive earthquakes occurred at Batangas on December 14, 1901, and in the centre of Mindanas on August 21, 1902. Lehmann and Plett wrote an interesting paper on the Philippine earthquake of November 13, 1925.

International Congress of Applied Mechanics

THE Seventh International Congress of Applied Mechanics will be held at the Imperial College of Science and Technology, South Kensington, London, during September 5–11. The technical sessions will be organised under the following sections: (1) Elasticity and Plasticity; (2) Aerodynamics, Hydrodynamics, Meteorology; (3) Thermodynamics, Heat Transfer, etc.; and (4) Vibrations, Lubrication and Experimental Methods. In addition, as many as ten general lectures or surveys are contemplated on subjects likely to be of interest to members. Arrange-

ments have been made for visits to the National Physical Laboratory, the Royal Aircraft Establishment, the National Gas Turbine Establishment, and the Research Laboratories of the General Electric Co., Ltd., during the week following the Congress. Forms of application for membership, and other material concerning the Congress, can be obtained from the Organising Secretary, Seventh International Congress of Applied Mechanics, Imperial College of Science and Technology, London, S.W.7.

Theories of Creep in Metals

A SUMMER school in theoretical physics, with particular application to creep in metals, will be held in the H. H. Wills Physical Laboratory of the University of Bristol during June 2–5. The course is intended mainly for members of the staffs of Government and industrial laboratories who wish to familiarize themselves with the theoretical side of subjects with which they have been concerned on the experimental side. Lectures will be given by Prof. N. F. Mott and other members of the staff of the H. H. Wills Physical Laboratory. In addition to the regular lectures, there will be opportunities for research workers attending the course to discuss their own work and its theoretical implications. Subjects to be treated will include: anelastic effects due to slip at grain boundaries; grain growth, recrystallization and the theory of grain boundary slip; geometry of dislocation and the theory of slip bands; theory of transient creep; slip in solid solutions; diffusion of carbon in iron and elastic after-effect; effects of carbon on the mechanical properties of iron; mechanisms of internal damping; crystal growth and the origin of dislocations. The number attending the course will be limited to about fifty, and the fee for attendance 5 guineas. Further particulars and forms of application, to be returned by April 15, can be obtained either from the Director of the Department of Adult Education, University of Bristol, or from the Secretary of the Institute of Physics, 47 Belgrave Square, London, S.W.1.

The University of Bristol, in co-operation with the Institute of Physics, announces also a second summer school in the physics of solids (experimental and theoretical) to take place in Bristol during September 8–15, the subject being "The Oxides and Ionic Crystals". Further details will be announced in due course.

University of London

DR. LESLIE YOUNG, reader in biochemistry in University College, London, and formerly professor of biochemistry in the University of Toronto, has been appointed to the university chair of biochemistry tenable at St. Thomas's Hospital Medical School as from April 1.

The degree of D.Sc. has been conferred on: Mr. W. S. Rogers (East Malling Research Station); Dr. B. N. Singh (Rothamsted Experimental Station); Mr. F. L. Warren (Royal Cancer Hospital (Free)).

Industrial Research in Wales

A REGIONAL conference on "Industry and Research in Wales", organised jointly by the Industrial Research Committee of the Federation of British Industries and the Industrial Association of Wales and Monmouthshire, will be held at Cardiff on March 10. Sir William Griffiths, managing director of the Mond Nickel Co., Ltd., will preside at the morning session and Sir Gerald Bruce, of the Industrial Association of Wales and Monmouthshire, in the afternoon. Among others taking part will be Sir Frederick Rees, principal of University College, Cardiff, Dr. W. D. Scott, of Monsanto Chemicals, Ltd., Capt. H. Leighton Davies, of the Steel Company of Wales, Ltd., Mr. Harry Davies, of I.C.I., Ltd., Dr. Idris Jones, of the National Coal Board, and Mr. R. K. Sanders, of the Metal Box Co., Ltd. Sir Percy Thomas, of the Welsh Board for Industry and the Industrial Association of Wales and Monmouthshire, will sum up. Further particulars can be obtained from the Industrial Research Secretariat, F.B.I., 21 Tothill Street, London, S.W.1, or from the Industrial Association of Wales and Monmouthshire, Aberdare House, Mountstuart Square, Cardiff.

Convention on Scientific Radio

A CONVENTION on Scientific Radio is to be held during April 7 and 8 by the Institution of Electrical Engineers and the British National Committee for Scientific Radio (set up under the auspices of the Royal Society), and is being organised by the Radio Section of the Institution. This is intended to serve as a preliminary survey of the British contribution in the radio field which is to be presented at the forthcoming meeting of the Union Radio Scientifique Internationale to be held in August 1948 in Stockholm. The Convention is divided into four sessions, corresponding in scope to those of the International Union, covering (1) standards and measurements; (2) propagation; (3) radio noise; and (4) radio physics.

Announcements

GENERAL SMUTS has been elected chancellor of the University of Cambridge in succession to the late Lord Baldwin.

DR. HAROLD SCARBOROUGH has been appointed lecturer with title of reader in the Department of Medicine, University of Birmingham.

THE Langley Memorial Prize, value £21, is open to competition among officers of the Colonial medical service who are serving, or who have served, in West Africa. The prize will be awarded for the best paper submitted on a topic falling within one of the following subjects (special consideration being given to original work): (*a*) tropical medicine or surgery; (*b*) tropical hygiene and sanitation; (*c*) tropical entomology and parasitology. Papers, which may consist of either published or unpublished work, should be delivered to the Assistant Dean, London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, not later than October 1, 1948.

THE trustees of the Lady Tata Memorial Fund invite applications for grants and scholarships, open to workers of any nationality, for research in diseases of the blood, with special reference to leukæmia, in the academic year beginning on October 1, 1948. Grants are made for research expenses or to provide scientific assistants to senior workers; scholarships (£400 per annum for whole-time research) are awarded as personal remuneration. Forms of application, to be returned before March 31, can be obtained by writing to the secretary of the Scientific Advisory Committee, Lady Tata Memorial Trust, c/o Medical Research Council, 38 Old Queen Street, Westminster, London, S.W.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A Short-Focus Modification of the Lamm Scale Method for Measuring Refractive Index Gradients

THE scale method is still regarded as the most accurate and reliable method for measuring refractive index gradients and is extensively used in diffusion and sedimentation measurements. The considerable laboratory space required by the long cameras is, however, inconvenient. I have studied the problem of the necessary focal length in detail, and come to the conclusion that the long focal length is not essential for the method.

Lamm[1] has given a number of reasons for using an objective with a great focal distance. It seems that several of these arguments are questionable. One requirement is essential, however, namely, the use of parallel or nearly parallel light through the cell. It was pointed out by Lamm himself (*loc. cit.*, p. 9) that it should be possible to attain this condition by placing the diaphragm in the focal plane of the objective, which could then have a much shorter focal length. This proposal has now been taken up for further study.

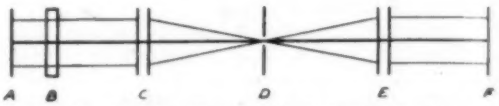
A camera giving an image of natural size with a diaphragm in the focal plane of the objective is not suitable, because a lens cannot be corrected for two purposes so widely different as giving exactly parallel light from the focal point and giving a good image of natural size. The former requirement is fulfilled by an asymmetrical astronomical objective, the latter necessitates a symmetrical lens system; to unite these two requirements, a compromise must be made in the correction of the lens, and a long focal-length may still be necessary.

It is not possible to solve this problem without introducing two lenses. An astronomical objective may be placed near the cell, and the diaphragm in its focal plane. A second lens can give a full-size image of the scale.

There are special advantages in placing the second lens at the focal distance from the diaphragm. In such a case the light is parallel on both sides of the lens system. In this arrangement both lenses should be of the simple astronomical type. From elementary optics it is known that a lens system of two lenses with a common focal plane has its principal planes infinitely far away; thus the magnification depends only on the two focal distances and not on the mutual distances between object, lens system and image. Needless to say, this latter property is of special advantage in the scale method, where the scale position in relation to the camera has to be altered several times during an experiment. If a confocal lens system is used, the magnification remains unaltered.

The magnification is equal to the ratio between the two focal distances. Since there is no reason for magnifying or reducing the scale image, I use two identical astronomical objectives in the camera. Two more advantages are gained by this: the magnification becomes exactly 1, which is very convenient, and the total length from the scale to its image is independent of the scale distance (the optical distance between scale and cell). Thus, if the scale distance is increased by 100 mm., the plate has to be moved 100 mm. in the same direction to restore the focusing, and the magnification of unity is unaltered.

In the original scale method, a correction factor $(l - b)/l$ (l is the distance between scale and lens, b is the scale distance) must be used to calculate the cell co-ordinate from the scale co-ordinate. In the new modification, this factor is also equal to unity, since the light travelling between the scale and the cell must be parallel. Thus the new modification simplifies the calculations considerably.



A, scale; *B*, cell; *C*, astronomical objective $f = 50$ cm.; *D*, diaphragm; *E*, astronomical objective $f = 50$ cm.; *F*, plate

A diagram of the new scale camera is reproduced herewith. It has been tested in diffusion measurements in this Institute for a couple of months and has given results indistinguishable from those obtained with the original method. Experiments will be continued to test the camera in connexion with ultracentrifugal and equilibrium centrifuge measurements.

The distance between scale and plate in our diffusion apparatus was 4 m. with the original scale method. It has now been reduced to 2 m. The corresponding distance in the ultracentrifuges and equilibrium centrifuges is 6 m.; thus 4 m. can be saved, and still more, since the centrifuge cells are considerably smaller than the diffusion cells. The focal length of the lenses can be reduced according to the size of the cell.

I wish to express my gratitude to Prof. Ole Lamm for the kind interest he has devoted to this work and for helpful discussions. I am also indebted to LKB-Produkter Fabriks-AB, Stockholm, for financial support.

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Oct. 1.

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Sensitivity of a South American Frog to Curare

FROM time to time, reports have appeared of the low sensitivity of South American frogs to curare[1,2].

These early experiments were made with crude curares, the reliability of which is always doubtful and in which apparent differences in potency may be due to differences in, for example, absorption-rate, produced by substances other than the curare alkaloids. We recently have had an opportunity of testing the sensitivity of *Leptodactylus ocellatus* to *d*-tubocurarine chloride supplied to us by Dr. Harold King, of the National Institute for Medical Research, Hampstead, London, N.W.3.

The tests were made at room temperature (21–24° C.) on frogs weighing between 25 and 70 gm., and the technique was the same as that described by King[2].

The *d*-tubocurarine chloride was dissolved in Ringer's solution and injected into the ventral lymph sac of the frogs in a volume of 0·02 c.c. per gm. of frog. The same end-point was used, namely, inability

of the frog to recover its normal posture when placed on its back.

Preliminary experiments on six frogs showed that doses up to 10 mgm./kgm. were without any visible effect. Of three frogs which received 15 mgm./kgm., one only became paralysed after 67 min. had elapsed. With doses of 20–30 mgm., paralysis developed in all frogs, but only after 19–50 min. A dose of 40 mgm./kgm. in three frogs produced paralysis in 18, 26 and 28 min.

Since the test described by King required paralysis to occur within 15 min., the dose was increased to 50 mgm./kgm., and this quantity was administered to six frogs. In these, paralysis developed in 13, 14, 14, 14, 15 and 16 min.

King[4] stated that for frogs the paralysing dose of *d*-tubocurarine chloride was 0·5 mgm./kgm. There appears to be no doubt that *Leptodactylus ocellatus* is considerably less sensitive to the alkaloid than is the *Rana temporaria* used for the original tests, a finding which confirms that of Houssay and Hug[3].

The comparison which we have made is, of course, unsatisfactory in many ways; but the experiments were limited by the supply of curarine immediately available. It is hoped in the near future to make comparisons simultaneously on the two amphibians under identical conditions.

This relative insensitivity of *Leptodactylus ocellatus* to substances affecting neuromuscular transmission does not seem to be confined to *d*-tubocurarine chloride, since we have recently found that this frog is less sensitive to acetylcholine than is *Rana esculenta*[5], although the difference is much less striking than in the instance of *d*-tubocurarine chloride. We have also found a similar insensitivity of these frogs to atropine injected arterially into the gastrocnemius muscle. In *Rana esculenta* one injection of 100 μgm. in 0·1 c.c. rapidly produced complete neuromuscular block[6]. In *Leptodactylus ocellatus* three successive injections of 200 μgm. in 0·2 c.c. only reduced the twitch tension to about a third of its original value.

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Nov. 5.

[1] Camis, M., *Rev. Faculd. Agron. Veterin. la Plata*, **11**, 27 (1915); *Arch. Farmacol. sp. Sci. afini*, **21**, 1 (1916).
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Sodium Citrate Concentration in Ether-extracted Plasma

A method has been described for the fractionation of human plasma in which fibrinogen is precipitated by ether, and prothrombin by adjusting the *p*H of the supernatant to 5·3 with 0·2 *M* citric acid[1]. The plasma remaining is frozen with excess of ether and the protein concentrated for use as a transfusion fluid[2]. We would like to direct attention to the fact that such solutions of proteins from citrated plasma may contain a dangerously high citrate concentration.

A transfusion reaction reported after the use of material prepared by the above method led us to examine the effects of its injection into rabbits, in which the injection of fluid or reconstituted dried pooled human plasma, where the protein is not concentrated, causes no disturbance of blood pressure or respiration.

When 5 ml. of the plasma used in the transfusion were injected into rabbits anæsthetized with 'Nembutal', there was an immediate fall in blood pressure, slowing of the heart-rate, an immediate acceleration of respiration succeeded by deep convulsive gasps or cessation of respiration and twitching movements of the musculature. Recovery usually occurred in a few minutes.

Dialysis of the plasma against distilled water using a collodion membrane removed the active factor. This, and the effects observed in the rabbit, suggested that the toxicity was due to citrate.

Estimation of citrate by the method of Pucher, Sherman and Vicary[3] showed the citrate concentration in pooled plasma to be about 11 mgm./c.c., in ether-extracted plasma about 15 mgm./c.c., and in plasmas prepared from fractionation residues to vary from 16·7 mgm./c.c. to 23·0 mgm./c.c. The injection of 5 ml. of ether-extracted plasma containing 22·5 mgm. citrate per c.c. produced the same effects in the anæsthetized rabbit as those caused by the injection of the plasma which produced the transfusion reaction. Injection of a similar quantity into unanæsthetized rabbits caused tetanic convulsions and opisthotonus. These effects could be reproduced by a citrate solution of the same strength. Dialysis of the plasma or the previous injection of calcium chloride prevented these effects; and injection of the dialysate, concentrated to the original plasma volume, showed that it contained the active agent, the effects of which were annulled by the previous injection of calcium chloride.

The manifestation of the toxic effects of citrate depends both upon the rate of injection and the concentration of citrate in the injected material. Since transfusions in certain conditions may be given very rapidly, we consider that the possibility that ether-extracted plasma prepared by the method of Kekwick, Mackay and Record[1] may contain a high concentration of citrate, which might under certain conditions prove toxic, should be made known.

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Effect of Antihistamines on *Daphnia*

Daphnia pulex reacts under ultra-violet radiation (wave-lengths less than 4000 A.) with negative phototaxis. In man the influence of the same wave-lengths is connected with release of histamine from damaged cells[1]. Successful therapy with antihistamine in cases of human hypersensitivity to sunlight is therefore not surprising[2]. The working hypothesis which we used was as follows: it is possible that the release of histamine occurs in both cases. If this assumption is correct, antihistamine should

modify the motor response of *Daphnia* (phototaxis) in the same way as it prevents the actinic dermal response in man subjected to sunshine.

As light source we used a low-pressure mercury vapour lamp. We tested typical antihistamine substances of well-known activity. They were: α-benzhydrylether-β-piperidinoethane (I)[3], antihistamine activity tested on guinea pig intestine: 6·3 microgm.; 2-phenylbenzylaminoethyl-imidazolin (II) (Antistin-Ciba), 45 microgm.; α-phenylamino-β-aminoethane (III)[4], 29 mgm. It was found that all these substances in small doses suppress the negative phototaxis of *Daphnia*; in larger doses, they invert the phototaxis to positive. This influence is proportional to the concentration of antihistamine used. The minimal effective dose for the substance I is 2·5 microgm. per c.c. of medium (M/133,000).

This reaction seems to be a specific one; it was not possible to provoke it with organic acids (acetic, lactic), lactose, glycocol and sodium choleinicum. Only strychnine among organic substances shows the same influence as antihistamines on *Daphnia*[5]. The mechanism of its action is clearly neurotropic. Further, it was found that the ratio of activity of three antihistamine substances in this *Daphnia* test was the same as in the test on the surviving intestine of the guinea pig. Therefore, it cannot be excluded that the actinic influence of ultra-violet light provokes the release of histamine in invertebrates as in man, although histamine itself, when added to the medium, did not influence *Daphnia* in any way.

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Oct. 13.

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Histaminolytic Activity of a Copper Protein in Serum

WE have recently been studying the blue serum globulin described by Luetscher[1], Pedersen[2], Holmberg[3] and Cohn *et al.*[4]. We have found that it has a copper content of about 0·05 per cent. By denaturing with a mixture of ethyl alcohol and chloroform and fractionating the supernatant solution with ammonium sulphate, we have found a blue copper protein with a copper content of 0·36 per cent. It seems very probable that this substance is identical with the hæmocuprein of Mann and Keilin[5], which thus might be an integral part of the blue globulin.

When a purified preparation of this globulin was added to plasma from a male subject so that the final copper concentration was about 700 γ/100 ml., the result was a 400-fold increase in histaminolytic activity. The blue globulin thus seems to be a component of the histaminolytic enzyme system of plasma.

As is well known, the increase in serum copper during pregnancy runs parallel in time with the increase in histaminolytic activity of plasma. We have also shown that this increase in copper is to be found in the globulin fraction of plasma.

A more detailed report of these investigations will soon appear in the *Acta Chemica Scandinavica*.

Our thanks are due to the Obstetrical Clinic of the Hospital of Malmö for help with the determinations of the histaminolytical activity of our preparations.

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Department of Clinical Chemistry,
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Oct. 27.

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Specific and Non-specific Competition in Tubular Excretion

A CONSIDERABLE number of aromatic acids are known to be excreted by the renal tubules. The chemical structure of these compounds shows much variety, and it does not seem easy to find any property common to them which is not also shared by substances not excreted by the tubules. However, in every case hitherto investigated, the tubular excretion of any anion is reversibly depressed by the presence of considerable amounts of other anions excreted by the tubules. This effect is usually demonstrated by the use of 'Diodrast' or hippuric acid as the depressing agent. The phenomenon is often regarded as an indication that the excretion of these compounds is effected by a common mechanism, or by intimately linked mechanisms.

It has, however, in some cases been shown that the presence of large amounts of 'Diodrast' in the blood may also interfere with reabsorptive processes in the tubules. This circumstance has led to the division of the effects of 'Diodrast' into specific and non-specific competition[1].

It seems clear that the depression of tubular excretion by 'Diodrast' may be non-specific, as well as its effect on tubular reabsorption. Thus the foundation for the view that the excretion of anions by the tubules is determined by specific interaction is considerably weakened by the demonstration of non-specific competition. In order to gain some further information as to the specificity of the depression of tubular excretion, the influence of hippuric acid on the excretion of uric acid has been studied in the chicken.

The intravenous injection of 100–200 mgm. hippuric acid causes the uric acid excretion in a hen to fall by 20–50 per cent for a short period (about ten minutes). Afterwards the uric acid excretion rises slightly above the original level for some time, but soon returns to it. This effect might be interpreted as the result of a diminution of the renal blood flow, possibly caused by the hippuric acid. However, the excretion of piperidine, which is also excreted by the tubules in the chicken, is not influenced in a consistent manner. This is evidence against an influence on the blood flow.

Similarly, the excretion of phenol red is depressed by the intravenous injection of uric acid. In this case the excretion of methylnicotinamide has been used to assess the constancy of the renal blood flow, which seems to be constant or slightly increased.

In man, uric acid is reabsorbed by the tubules; the reabsorption is depressed by 'Diodrast'[1]. It is thus clear that the depression by hippuric acid (or 'Diodrast') cannot be regarded as demonstrating excretion by a common mechanism. Though there is no doubt about the existence of both specific and non-specific competition, it seems that we are at present unable to distinguish between these two phenomena.

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Improved Method of Getting Rats' Eggs from the Fallopian Tubes

Rowlands[1] described the recovery of rats' eggs by unravelling the Fallopian tubes and squeezing out their contents under low-power magnification. Using this method he obtained an average of $4{\cdot}9 \pm 0{\cdot}5$ (standard error of the mean) ova per rat from the tubes of thirteen normal rats two days after mating[2]. Using the same method in forty rats killed 0–2 days after mating, we recovered a similar number of eggs ($4{\cdot}2 \pm 0{\cdot}3$ per rat).

A significantly higher average recovery was obtained when the ova were washed out of the Fallopian tubes. A blunted hypodermic needle (26 wire gauge) can easily be inserted into the open ovarian end of the unravelled tube (or into an oblique slit made just below it) and the ova washed out with five to ten drops of physiological saline from a 1-ml. syringe. The washing method is only preferable when the eggs are no longer clumped together surrounded by cumulus cells but are scattered free throughout the length of the tube—that is, more than 24 hr. after mating. Before this time the original method is the better one. By the modified technique the average number of eggs recovered from thirty-six rats 0–2 days after mating was $7{\cdot}8 \pm 0{\cdot}4$ eggs per rat, a number more in keeping with the normal litter size.

This work was initiated when one of us (P. C. W.) was Prophit Research Student of the Royal College of Surgeons, and it was aided by an apparatus grant from the University of London.

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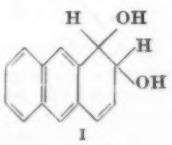
Oxidation of Anthracene by Osmium Tetroxide

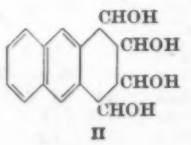
We have shown recently[1] that the addition of osmium tetroxide to the 9 : 10-positions of phenanthrene, first observed by Criegee, Marchand and Wannowius[2], is a general property in a series of tetra- and penta-cyclic aromatic hydrocarbons containing a phenanthrene system. If the reaction is carried out in the presence of pyridine a well-crystallized, deep-coloured, pyridine-osmic ester complex is formed, and this on hydrolysis gives a dihydroxydihydro derivative of the original hydrocarbon.

The presence of a phenanthrene system is not essential, for anthracene and naphthalene form similar coloured complexes. If, in the case of anthracene, the reaction could be limited to addition of osmium tetroxide to *one* aromatic double bond, then it is probable that hydrolysis would give *dl-cis*-1 : 2-dihydroanthracene-1 : 2-diol (I), which Boyland and Shoppee[3] have shown to be the metabolic oxidation product of anthracene in rabbits. Whether the reaction could, in fact, be so limited seemed very doubtful as addition of osmium tetroxide to anthracene takes place slowly, and the product of addition of one molecule of the tetroxide would contain a true ethylenic linkage which should react rapidly with a second molecule of osmium tetroxide with formation of an osmic ester complex of a tetrol.

This conclusion has been verified experimentally, for hydrolysis of the anthracene-osmium tetroxide-pyridine complex gave a tetrahydroxytetrahydroanthracene. If the above reasoning is sound, this should be the 1 : 2 : 3 : 4-tetrahydro compound. That this is indeed the case was supported by a measurement of the ultra-violet absorption spectrum by Mr. E. J. Y. Scott, who found log $\varepsilon = 5{\cdot}25$ at 2330 A. for a methanolic solution of the tetrol (2·34 mgm. in 500 ml.). This suggests a naphthalene derivative (II), and final confirmation of this was provided by oxidation of the tetrol by alkaline potassium ferricyanide solution to naphthalene-2 : 3-dicarboxylic acid, m.p. 238–239° alone or mixed with a sample prepared by similar oxidation of 2 : 3-dimethylnaphthalene. It is noteworthy that the very reactive *meso* positions of anthracene are not attacked in this method of oxidation.



I



II

To obtain the tetrol a solution of anthracene (0·0025 mol.), osmium tetroxide (0·005 mol.) and pyridine (0·01 mol.) in pure benzene (20 ml.) was kept at room temperature for a fortnight with occasional shaking. The brown osmic ester complex which had separated was collected, washed with benzene, and dried in the air. It (1 gm.) was hydrolysed by heating on the water bath for three-quarters of an hour with a solution of crystalline sodium sulphite (5 gm.) in water (25 ml.) and ethanol (25 ml.). More ethanol was then added to precipitate the salts remaining in solution, and the whole was filtered. The black residue was extracted several times with hot alcohol, the extracts combined with the original filtrate, and the combined liquors concentrated under reduced pressure. The solid which separated after cooling was recrystallized from water, giving almost colourless leaflets (80 mgm.) of 1 : 2 : 3 : 4-*tetrahydroxy*-1 : 2 : 3 : 4-*tetrahydroanthracene* (II), m.p. 241° (decomp.) (found : C, 68·2; H, 5·8. $C_{14}H_{14}O_4$ requires C, 68·3; H, 5·7 per cent). Its *tetraacetate*, obtained with boiling acetic anhydride-pyridine and purified by chromatography on silica, crystallized from benzene – light petroleum in colour-

less prisms, m.p. 215–217° (found: C, 64·0; H, 5·2. $C_{22}H_{12}O_2$ requires C, 63·8; H, 5·3 per cent).

We thank the British Empire Cancer Campaign for a grant.

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Nov. 20.

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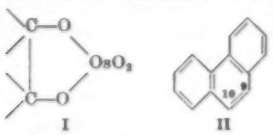
Relative Reactivity of Aromatic Double Bonds

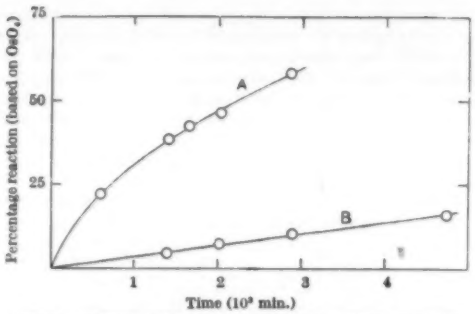
It is well known that osmium tetroxide readily reacts with ethylenic double bonds[1] with the formation of osmic esters (I), which may be converted into *cis*-diols. Criegee *et al.*[2] have found that phenanthrene (II) also reacts with osmium tetroxide. When the reaction was carried out in a non-aqueous solvent containing a little pyridine, a dark brown complex of 9 : 10-dihydrophenanthrene-9 : 10-diol-osmate and two molecules of pyridine was formed. Cook and Schoental[3] have recently extended this reaction to many other polycyclic aromatic hydrocarbons, and in every case addition to adjacent carbon atoms was found to take place, with the formation of a brown complex. With 1 : 2-benzanthracene (III), for example, reaction took place at the 3 : 4 positions. It seemed to us, therefore, that this reaction might be used to compare the relative reactivities of aromatic double bonds.



I II III

In a preliminary experiment with anthracene, phenanthrene and 1 : 2-benzanthracene, the hydrocarbon (0·0005 *M*) in pure benzene (15 c.c.) and pyridine (0·15 c.c.) was treated with osmium tetroxide (0·0005 *M*). As judged by the colours of the solutions at suitable intervals, anthracene and 1 : 2-benzanthracene appeared to be approximately equally reactive, and both seemed to react very much faster than phenanthrene. In view of this surprising result, we have carried out a more detailed comparison between phenanthrene and 1 : 2-benzanthracene. (Anthracene is not entirely satisfactory for comparison with phenanthrene, for Cook and Schoental[4] have found that this hydrocarbon reacts with two molecules of osmium tetroxide to form a complex which on hydrolysis yields a tetrol, and we are making a separate investigation of this reaction-rate.)

For the more accurate investigation we have carried out the reaction between the hydrocarbons and osmium tetroxide in chloroform solution, at 30° C.; aliquot portions being taken at suitable intervals and diluted with chloroform and pyridine. The colour intensities of these solutions were then estimated with a Spekker absorptiometer, using green filters. The instrument was calibrated with known concentrations of the appropriate complex; and it was also shown that absorption with an osmium tetroxide – chloroform – pyridine solution, which was yellow in colour, was negligible compared with that of the solution of the complex. The rates of reaction were measured under conditions leading to the production of a second-order rate-constant. The initial concentration of 1 : 2-benzanthracene was 0·04994 *M*, of phenanthrene 0·04996 *M*, and of osmium tetroxide 0·01354 *M*. With 1 : 2-benzanthracene, the reaction was followed until approximately 60 per cent of the osmium tetroxide had been consumed, and the mean rate-constant was found to be $1{\cdot}2 \times 10^{-4}$ (gm. mol. sec./litre)$^{-1}$. With phenanthrene, the rate constant was found to be $1{\cdot}2 \times 10^{-5}$ (gm. mol. sec./litre)$^{-1}$, the reaction being followed until 16 per cent of the osmium tetroxide had been used. 1 : 2-Benzanthracene, therefore, reacts approximately ten times as rapidly as phenanthrene (see graph).



Curves showing rate of reaction of osmium tetroxide with 1 : 2-benzanthracene (curve *A*) and phenanthrene (curve *B*)

It is clear, therefore, that the reaction offers a useful method, not previously available, for the quantitative comparison of the relative reactivity of aromatic double bonds, and it may possibly prove useful in investigations on the Mills–Nixon effect and on bond fixation due to hydrogen bonding. The present investigation was undertaken in an attempt to estimate the validity of the quantum-mechanical calculations of Pullman[5], who has developed a theory attempting to correlate carcinogenic activity of polycyclic aromatic hydrocarbons with an optimum density of π-electrons at the *K* position (the 3 : 4 bond in benzanthracene). Her calculations for phenanthrene and benzanthracene do not appear to be in accord with our experimental results.

This work is being continued and extended.

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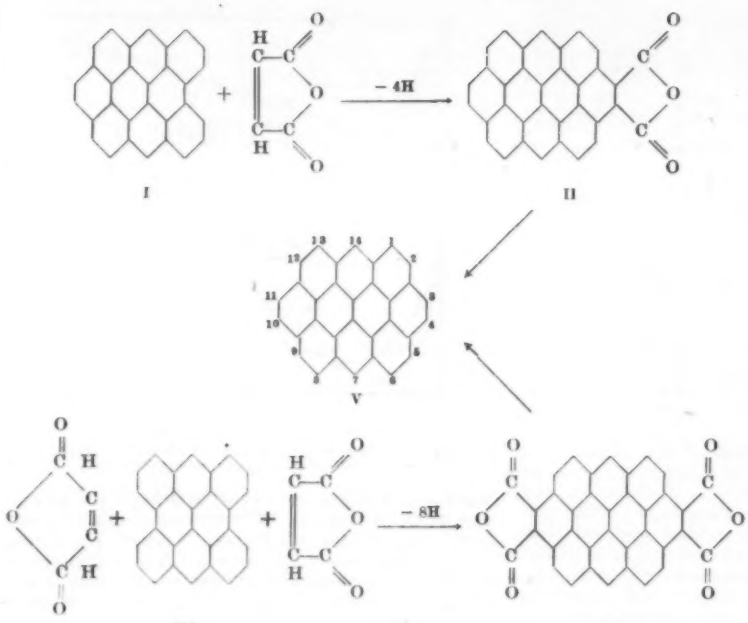
[1] Criegee, R., *Ann.*, **522**, 75 (1936).
[2] Criegee, R., Marchand, B., and Wannowius, H., *Ann.*, **550**, 99 (1942).
[3] Cook, J. W., and Schoental, R., *J. Chem. Soc.*, in the press.
[4] Cook, J. W., and Schoental, R., *Nature*, preceding communication.
[5] Pullman, A., Thesis, Paris, 1946; *Ann. Chim.*, **2**, 5 (1947). See also Pullman, A., and Pullman, B., *Experientia*, **2**, 364 (1946); *Rev. Sci.*, **84**, 145 (1946).

Synthesis of Ovalene

If perylene is boiled with maleic anhydride and nitrobenzene, 1 : 12-benzperylene-1′ : 2′-dicarboxylic acid anhydride is formed[1]. Under the same conditions *meso*-anthra-dianthrene[2] (I) yields quantitatively the anhydride (II), as dark red needles decomposing at 430° (uncorr.) (found: C, 86·48; H, 3·01. $C_{34}H_{12}O_3$ requires: C, 87·17; H, 2·58 per cent),



and *meso*-naphtha-dianthrene[2] (III) reacts twice to form the dianhydride (IV), as dark brown crystals, carbonizing at high temperature.

Both anhydrides II and IV give by decarboxylation with soda-lime at 400° in vacuum the same hydrocarbon (V), which consists of a naphthalene system surrounded by eight benzene rings. I have called it 'ovalene'. In the analogous hydrocarbon coronene one benzene ring is surrounded by six benzene rings. In the series *meso*-naphtha-dianthrene (III), *meso*-anthra-dianthrene (I), and ovalene (V), there is a change in colour from deep blue-green to violet and light orange-yellow, while perylene is golden, 1 : 12-benzperylene pale yellow and coronene paler yellow.

Ovalene sublimes in beautiful light orange needles. It can be recrystallized from 1-methylnaphthalene and melts at 473° (uncorr. evacuated, capillary). It dissolves in concentrated sulphuric acid to give a violet solution which becomes brown. The very dilute solution in benzene shows an orange fluorescence. $C_{32}H_{14}$ (398·43): cal. C, 96·46; H, 3·54; found C, 96·61; H, 3·72 per cent.

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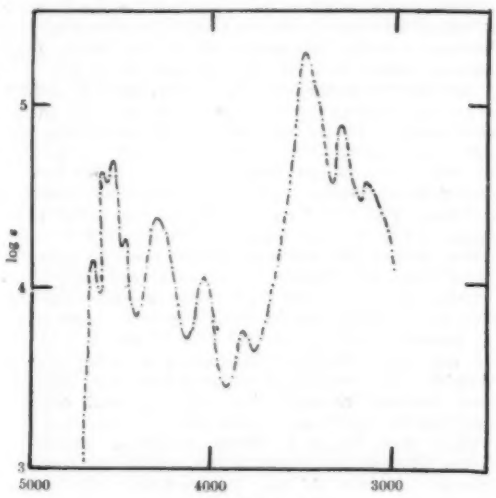
[1] Clar, E., *Ber.*, **65**, 846 (1932).

[2] Scholl and Meyer, *Ber.*, **67**, 1229, 1236 (1934). Both hydrocarbons are more easily obtained by the zinc dust melt; Clar, E., *Ber.*, **72**, 1645 (1939).



Absorption spectra of ovalene, in 1-methylnaphthalene for the longer wave-lengths up to 3400 A., and in benzene for the shorter wave-lengths. The following are positions of the band maxima in 1-methylnaphthalene in A.: 4650, 4600; 4560, 4480, 4280, 4035, 3820; 3490; in benzene: 4635, 4585; 4525, 4450, 4250; 3450, 3300, 3150

Colour Reagents for the Paper Chromatography of Sugars

The application of paper chromatography to the separation[1], identification, and quantitative microdetermination[2] of the sugars, in investigations of the carbohydrate group, is an advance of no small importance. However, the use of ammoniacal silver nitrate, which gives a similarly coloured dark spot with all the reducing sugars, as colour reagent, often leads to uncertainty, especially when the *RF* values of the sugars are close.

In a current investigation of a polysaccharide, for example, which I carried out at the Chemical Laboratories of the University of Manchester, it was necessary to decide which one of the group, mannose, fructose, arabinose, was present in addition to several other sugars. The fact that the possibles were an aldose, ketose and pentose suggested the use of an acid solution of one of the phenols (phloroglucinol, orcinol, etc.) as a colour reagent. These phenols have long been used to test for the various groups of sugars, but are of limited use when dealing with complex mixtures in solution. This limitation is overcome by the spatial separation of the sugars during chromatography.

It has been found that colour reactions are readily obtained if the chromatogram, after preparation and drying in the usual manner, is sprayed with a solution of the phenol (10 ml. 1 per cent alcoholic solution

Phenols	Time of drying (min.)	Background	Galactose Glucose Mannose	Fructose	Xylose Arabinose	Rhamnose
Resorcinol	3	—	—	Red	—	—
	10	Pink	—	Red	Blue	Yellow
Naphtharesorcinol	10	Pink	Grey	Brown	Blue	Green

in 90 ml. 2*N* hydrochloric acid) and dried for 10 min. at 85–95° C.

Phloroglucinol, orcinol, α-naphthol, resorcinol and naphtharesorcinol were tested. Resorcinol and naphtharesorcinol proved of wide application, and the colours obtained are shown in the accompanying table.

About 1 μl. of a 1 per cent solution of the sugar was spotted on filter paper and sprayed. The same colours were obtained in their proper spatial distribution when chromatograms of complex mixtures of the sugars were sprayed.

The qualitative identification of the sugars in a complex mixture is readily obtained in practice by spotting on six alternate spots of unknown and standard mixture. After running and drying, the paper is cut into three strips and sprayed with ammoniacal silver nitrate, resorcinol and naphtharesorcinol respectively. As standard mixture a solution of galactose, fructose, xylose and rhamnose (each sugar in 1 per cent concentration) is most suitable. By comparing the position and the colour of the spots on the strips an accurate picture of the composition of the mixture is obtained. Usually a satisfactory result can be obtained by merely spraying the whole chromatogram with naphtharesorcinol. Mannose and arabinose, which especially present difficulty in paper chromatography, are readily differentiated by a resorcinol spray.

It should be noted that non-reducing sugars such as sucrose also give a positive reaction.

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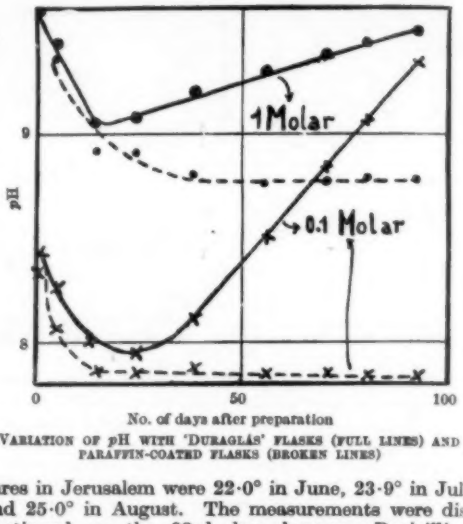
Oct. 20.

[1] Partridge, S. M., *Nature*, **158**, 270 (1946).
[2] Flood, A. E., Hirst, E. L., and Jones, J. K. N., *Nature*, **160**, 86 (1947).

*p*H of Trisodium Citrate Solutions Stored under Customary Laboratory Conditions

During research on certain metallic complexes of citrate[1,2], we have observed that the *p*H of trisodium citrate solutions depends somewhat on their 'age'. Solutions, prepared at various times, showed differences of as much as 1·3 *p*H, though raw materials, methods of preparation and concentrations were identical. In view of the widespread chemical and clinical use of such solutions, it seemed of interest to investigate this phenomenon.

Two samples of a 0·1 molar and two of a 1 molar trisodium citrate solution were prepared by dissolving sodium citrate, gran., B.P. (supplied by Messrs. May and Baker, Ltd.) in distilled water. One sample of each concentration was stored in a 'Duraglas' brand flask (purchased from Messrs. Eimer and Amend, New York), and another in a flask coated with pure paraffin wax. The samples were kept under ordinary laboratory conditions for 92 days (June 2–September 1, 1947) and their *p*H was measured at intervals of 10–15 days. During this period the mean temperatures in Jerusalem were 22·0° in June, 23·9° in July and 25·0° in August. The measurements were discontinued on the 93rd day, because *Penicillium* moulds made their appearance. The *p*H measurements were carried out at 30° ± 0·1°, with a precision of ± 0·02 *p*H, using a Cambridge *p*H-meter (bench type).



Variation of *p*H with 'Duraglas' flasks (full lines) and paraffin-coated flasks (broken lines)

Results are plotted in the accompanying graph. During the first two to four weeks, there was a decrease in the *p*H of all four solutions. From this time onward, however, the solutions in paraffin-coated flasks showed practically *no further change*. Contrary to this, the two solutions stored in flasks with unprotected glass walls exhibited a continuous rise of *p*H, from the 24th to the 92nd day. This is consistent with the assumption that some of the glass is being dissolved. The rise of *p*H is about 1·3 for the 0·1 molar solution and only 0·5 for the 1 molar solution, both corresponding to the same approximate increase of the concentration of hydroxyl ions, namely, about 2×10^{-5} equivalents per litre.

In order to ascertain how carbon dioxide (which is present both in the distilled water used and in the atmosphere) affects the *p*H of the solutions, the following experiments were carried out. Solutions of trisodium citrate were prepared, using freshly boiled distilled water, and stored in flasks with paraffin coating. The *p*H of these solutions was found to be higher than of those prepared with unboiled water. Then, carbon dioxide was bubbled through them for thirty minutes. The *p*H, measured immediately afterwards, was much lower than any previously observed, but not constant enough for accurate determination. It increased slowly (at the rate of about 0·15 per 15 minutes), obviously because of escaping carbon dioxide. To obtain a constant value, pure nitrogen was bubbled through the solutions and the *p*H checked at intervals. After three hours, final *p*H values were reached, which remained unchanged when nitrogen was bubbled through for another two hours. Results of the experiments with carbon dioxide are summed up in the accompanying table.

It appears that the *p*H of pure uncontaminated trisodium citrate is about 9 in a 0·1-molar solution and 10·3 in molar solution. Solutions exposed to atmospheric carbon dioxide show a gradual decrease of *p*H (see graph) until constant values (7·8 for the 0·1-molar solution and 8·8 for the molar solution)

ACTION OF CARBON DIOXIDE

Molarity of trisodium citrate	pH						
	In CO_2-free solutions	After saturation with CO_2	After bubbling nitrogen through solutions				
			1 hr.	2 hr.	3 hr.	4 hr.	5 hr.
0·1	8·97	6·20–6·35*	6·91	7·43	7·82	7·86	7·84
1	10·30	6·90–7·03*	7·65	8·20	8·76	8·72	8·70

* *p*H not constant: rises at a rate of about 0·15 per 15 min.

are reached, after the lapse of three to four weeks. The same final *p*H may be obtained within a few hours (see table) by bubbling successively carbon dioxide and nitrogen through the solutions.

Citrate solutions ought, therefore, to be stored in paraffin-coated flasks if it is desired to keep their *p*H constant; furthermore, contamination by carbon dioxide must be avoided.

We have pleasure in thanking Miss T. Rayss for examining the *Penicillium* moulds.

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[1] *J. Amer. Chem. Soc.*, **67**, 1824 (1945).
[2] *J. Amer. Chem. Soc.*, in the press.

Preparation of Rare-Earth Chlorides

THE preparation of chlorides of the rare-earth elements directly from monazite by chlorination in the presence of carbon possesses certain advantages over conventional methods. (1) Phosphorus is volatilized as oxychloride in a single operation and the chlorides may be obtained phosphate-free. Conventional methods involve lengthy operations for its complete removal, particularly from thorium. (2) Impurities present in the mineral (as well as those in the added carbon) are largely eliminated as volatile chlorides; for example, as the chlorides of iron, silicon, titanium, aluminium, zirconium and tin. (3) The anhydrous chlorides produced may be extracted either in water or non-aqueous solvents or recovered in a molten state.

The reaction has been studied by briquetting the powdered phosphate with wood charcoal, using rare-earth chlorides as a binding agent. The dried briquettes were heated to reaction temperature in a vertical tube, and a known weight of chlorine passed. Nitrogen was passed through the charge before and after reaction to remove moisture and oxygen and to displace residual volatiles. Condensation of phosphorus oxychloride served as a guide to the progress of reaction. The chlorinated briquettes were extracted with dilute nitric acid (*p*H 2), and the yield estimated by analysis of this solution.

Reaction proceeded smoothly when the phosphate and charcoal were finely ground and when the temperature was as close as possible to the sintering temperature of the briquettes (700–750° C.). The consumption of carbon indicated that the approximate course of the reaction was

$$RPO_4 + 3C + 3Cl_2 \rightarrow RCl_3 + POCl_3 + 3CO.$$

(*R* stands for rare-earth elements: a similar expression holds for thorium.) Some results are given in the accompanying table. The conditions were as follows. Temperature, 700° C.; dimensions of charge: height, 7 cm., cross-section, 2·6 cm.^{2}, weight, 50 gm.; weight-ratio monazite/carbon, 6·7; particle sizes, Tyler screens: phosphate, 100%–325, charcoal, 100%–200, briquettes, − 6 + 10; RCl_3, 1 gm. per 50 gm. of charge; monazite analysis: rare-earth oxides, 59·7 per cent; ThO_2, 6·8 per cent; P_2O_5, 27·4 per cent; insoluble in sulphuric acid, 2·0 per cent; ash in charcoal, 7·8 per cent.

Chlorine passed††		Yield*, %		Overall chlorine efficiency**
(gm./min.)	total (gm.)	R_2O_3	ThO_2	
0·19	20	41	0·1	64†
	30	63	2·9	70†
	40	90	14	75†
	50	91	17	61
0·50	20	49	trace	79†
	31	62	0·40	67
	41	73	0·65	58
	95	89	9·2	31
0·70	20	34	Nil	56
	30	47	trace	52
	40	54	0·10	45
	145	90	9·1	21

* Corrected for RCl_3 used as binder.
** Calculated from data in columns 2, 3 and 4.
† No free chlorine evolved.
†† Theoretical consumption of chlorine, 33 gm.

No phosphate was detected in the extracts, which contained only small quantities of impurities, chiefly calcium and magnesium chlorides.

Under optimum conditions, it is therefore possible to obtain a 90 per cent yield of rare-earth chlorides of very satisfactory purity for an overall chlorine efficiency of 75 per cent. The real efficiency is undoubtedly greater than this, because several grams of chlorine are consumed by impurities. The time required to produce a 90 per cent yield is almost independent of the flow-rate; but the rate of reaction falls off very markedly after a 90 per cent yield has been attained.

Thorium is not chlorinated until approximately 50 per cent of the rare earths has been attacked, and thereafter reacts much more slowly than the latter. After extraction of soluble chlorides and separation of unconsumed carbon, a residue is obtained which corresponds in composition to a rare-earth phosphate in which the weight ratio $ThO_2/(ThO_2 + R_2O_3)$ has been increased from an initial value of 0·10 to 0·45.

At 800° C. the reaction becomes rapid, but the chlorides melt and a considerable amount of thorium chloride volatilizes. The reaction at high temperatures is under further investigation. A fuller account of results and experimental procedures will be published elsewhere.

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Mechanism of Conductance by Hydrogen and Hydroxyl Ions in Aqueous Solutions

IT has been suggested[1–5] that the process of electrolytic conduction by hydrogen and hydroxyl ion in water involves, in addition to the mass transport of the hydrated ions, a proton transmission mechanism. This mechanism yields by means of a relatively small motion (*c.* 0·4 A.) of a proton as great a charge transport as would result from a much larger (*c.* 3 A.) motion of the entire ion.

I have attempted to determine whether this mechanism is, in fact, involved by measurement of the conductances of rapidly frozen aqueous solutions of electrolytes—solutions in which the contribution of the mass transport mechanism is presumably greatly depressed. Solutions of hydrochloric acid, nitric acid, hydrofluoric acid, potassium hydroxide, lithium hydroxide, potassium chloride, and lithium fluoride were cooled rapidly to liquid-air temperature, then heated to the temperature at which the conductance was to be determined. The conductances were determined in the temperature range − 120° C. to − 40° C. Each system was studied at temperatures lower than its lowest reported eutectic temperature; at these temperatures the frozen masses appeared solid and felt hard. At liquid-air temperature in all cases the specific conductances were less than the limit of detection (2×10^{-10} mho cm.$^{-1}$) of the apparatus. As the frozen solutions of the acids and bases were warmed to the temperature of measurement, the conductance rose quickly to a maximum, then decreased over a period of hours (presumably the decrease arises from a slow phase separation). The frozen solutions of salts showed no conductance at temperatures below their eutectics; this observation supports the assumption that the mass transport mechanism is insignificant. The maximum conductance was taken as characteristic of the acid and base solutions at each temperature. The measurements were made with a direct-current instrument at fields of 1–10 volts cm.$^{-1}$ and current densities at 10^{-2}–10^{-6} amp. cm.$^{-2}$.

The value of the conductance for a given solution and temperature could be reproduced only to within a factor of two or three, probably because of the cracking of the solid and variations in the amounts of solute 'frozen in'. Following are some typical results:

Substance	Temperature	Specific conductance
0·06 *N* HCl	− 115° C.	6×10^{-9} mho cm.$^{-1}$
0·06 *N* HCl	− 106	3×10^{-8}
0·06 *N* HCl	− 84	9×10^{-8}
0·08 *N* LiOH	− 69	2×10^{-9}
0·08 *N* LiOH	− 51	$1{\cdot}5 \times 10^{-9}$
0·08 *N* LiOH	− 42	2×10^{-9}
0·056 *N* NHO_3	− 84	3×10^{-9}
0·056 *N* HNO_3	− 70	1×10^{-8}

The observation that the frozen solutions conduct strengthens the suggestion that the proton transmission mechanism contributes to the mobility of hydrogen and hydroxyl ions in aqueous solutions. It may be worthy of mention that estimates of activation energies for the conduction process, made either from ratios of conductances at various temperatures or by application of the absolute rate theory of Stearn and Eyring to the equivalent conductances at each temperature, yield values between 6 and 10 kcal. mole^{-1}. These values are, of course, very uncertain; nevertheless, they may suggest that rotation in the lattice is rate-determining, since the activation energy for rotation of a water molecule in ice has been estimated from the temperature dependence of relaxation time of polarization to be about 8 kcal. mole^{-1}.

In any event, it seems that the pure proton tunnelling mechanism of Bernal and Fowler cannot be the only one involved. Both the strong temperature-dependence of conductance in ice and the fact that deuterium ion in heavy water has an abnormally high conductance lead to this conclusion. Whether the tunnelling effect contributes significantly cannot be decided easily because of the control over the rate by rotation or some other comparatively slow process.

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[1] Huckel, *Z. Elektrochem.*, **34**, 546 (1928).
[2] Bernal and Fowler, *J. Chem. Phys.*, **1**, 515 (1933).
[3] Wannier, *Ann. d. Phys.*, **24**, 545 (1935).
[4] Stearn and Eyring, *J. Chem. Phys.*, **5**, 113 (1937).
[5] Frenkel, *J. Phys. U.S.S.R.*, **5**, 31 (1941).

Volumetric Estimation of Thallium

A number of processes have been described for the volumetric estimation of thallium. All these methods are based on the oxidation of thallium from the thallous to the thallic state by potassium permanganate[1], bromate[2], iodate[3] or ceric sulphate[4] solutions; but no attempt has been made to use a precipitation reaction for this determination.

Bromophenolblue (tetrabromo - phenolsulphonaphthalein), which has been used previously as an acid–alkali indicator and as an adsorption indicator[5] in the determination of mercurous ions, has been found by me to be a very suitable indicator for the determination of thallous ions also. 10 c.c. of $N/10$ potassium iodide is mixed with four drops of 0·1 per cent solution of bromophenolblue in alcohol, and thallous nitrate solution (about $M/10$) is run in from the burette. When the exact equivalent amount of the solution has been added, half a drop in excess of the solution turns the yellow-coloured precipitate to a beautiful green colour, the end-point being reversible.

Further work is in progress. The details of the process will be published in detail elsewhere.

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Sept. 7.

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[4] Willard and Young, *J. Amer. Chem. Soc.*, **52**, 36 (1930).
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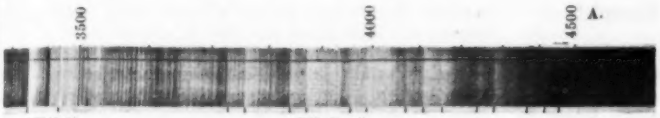
Band Spectrum of ClO in Flames

Band systems attributed to the monoxides of bromine and iodine have been obtained by Vaidya[1,2] in flames of ethyl bromide and methyl iodide. Recently, Coleman and Gaydon[3] have made a further study of the BrO bands using various flames, including one of hydrogen burning in a mixture of oxygen and bromine vapour; the occurrence of the bands in this flame supports the assignment to BrO. There does not appear to be any detailed record of the corresponding band system of ClO, although Urey and Bates[4] reported the existence of a band system, which they thought to be due to ClO, when chlorine was introduced into an oxy-hydrogen flame. As part of a series of investigations on the inhibitory action of halogen compounds on flames, we have examined the spectrum of a flame of hydrogen burning in an atmosphere of oxygen mixed with a little chlorine. A system of bands has been obtained in the blue to near ultra-violet, which appear to be analogous to the known systems of BrO and IO and



SPECTRUM OF THE FLAME OF HYDROGEN BURNING IN A MIXTURE OF OXYGEN AND CHLORINE

which may therefore be assigned to ClO. The bands do not occur readily when chlorine is introduced into a carbon monoxide – oxygen flame, but have been observed, very weakly, in the outer cone of a methyl chloride – oxygen flame.

The bands, which are superposed on a fairly strong continuous background, are degraded to the red and appear to possess a fairly simple vibrational structure. Unfortunately, the heads are not well defined, and overlapping by strong bands of OH renders accurate measurement and reliable analysis difficult. Photographs have been taken with a medium quartz spectrograph (as in illustration), using plates of high contrast, and also with a large Littrow-type quartz spectrograph giving a dispersion of about 5 A./mm. in the region of the bands. Under the large dispersion the rotational structure is seen to be complex; heads are difficult to locate, and the chlorine isotope effect could not be found owing to the complexity. With the smaller dispersion, the band heads listed in the accompanying table were measured; the measures

BAND HEADS OF ClO

λ	I	ν	v′	v″	λ	I	ν	v′	v″
4502	2	22206	4	10 + x	3991	8	25049	1	4 + x
4459	3	22420	3	9 + x	3957	7	25265	0	3 + x
4417	3	22633	2	8 + x	3874	10	25806	1	3 + x
4373	3	22861	1	7 + x	3841	10	26027	0	2 + x
4335	1	23062	3	8 + x	3761	9	26581	1	2 + x
4293	7	23341	2	7 + x	3729·5	7	26805	0	1 + x
4241	5	23573	1	6 + x	3652·5	6	27371	1	1 + x
4154	4	24066	2	6 + x	3625	3	27578	0	0 + x
4114	9	24300	1	5 + x	3587	2	27871	2	1 + x
4078	6	24515	0	4 + x					

are accurate to about 2 A. in most cases, but in a few difficult cases there is a possibility of errors so large as 5 A. The bands have been arranged into a provisional vibrational scheme using intervals of about 780 cm.$^{-1}$, decreasing to less than 700 for ω'' and about 550 cm.$^{-1}$ for ω'. The bands fall on an open Franck–Condon parabola, and it is not possible to assign definite values for v''; it would not be surprising if x in the table was about 3, making ω'' a little more than 800 cm.$^{-1}$.

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[1] Valdya, W. M., *Proc. Indian Acad. Sci.*, **7** A, 321 (1938).
[2] Valdya, W. M., *Proc. Indian Acad. Sci.*, **6** A, 122 (1937).
[3] Coleman, E. H., and Gaydon, A. G., *Trans. Farad. Soc.*, in the press.
[4] Urey, H. C., and Bates, J. R., *Phys. Rev.*, **34**, 1541 (1929).

Interaction Terms in Molecular Vibrations

IN a recent communication[1], Coulson, Duchesne and Manneback have pointed out that the positive sign of the cross-term constant, g_c, in the P.E. function of the water molecule

$$2V = f_1(\overline{\Delta r_1}^2 + \overline{\Delta r_2}^2) + 2f_{12}.\Delta r_1.\Delta r_2 + r_1r_2f_\theta.\overline{\Delta\theta}^2 + 2r_1g_c(\Delta r_1 + \Delta r_2).\Delta\theta$$

can be accounted for by supposing that the hybridization of the oxygen bond-forming orbitals changes during a vibration. We had come to exactly the same conclusion, and our reasons for this are contained in a communication to the Faraday Society which is awaiting publication[2].

We were led to our conclusion more particularly by the sign of f_{12}, which is negative. This implies that, as one OH-bond contracts, the other tends to contract also. We had first supposed that the departure from the simple valency force-field might be due to repulsion between the hydrogen atoms. But, if this were so, movement of one hydrogen atom towards the oxygen atom would force the other away. We were therefore led to conclude that as one OH-bond contracts it assumes more *s*-character, which results in the other bond assuming more *s*-character and its equilibrium-length decreasing. This explanation was confirmed by the fact that it accounted for the positive sign of g_c also. So we concluded that the size of the HOH angle was due to the fact that the oxygen bond-forming orbitals in water had considerable *s*-character, rather than because of repulsion between the hydrogen atoms.

If the repulsion between the hydrogen atoms is given by

$$V = V_0 + A(\Delta R) + \tfrac{1}{2}B(\Delta R)^2$$

for small displacements, ΔR, from the HH distance in the equilibrium configuration, the contribution of A and B to the cross-terms f_{12} and g_c can be shown to be

$$0{\cdot}313\,B - 0{\cdot}124\,A \quad \text{to} \quad f_{12}$$
$$0{\cdot}242\,B + 0{\cdot}160\,A \quad \text{to} \quad g_c.$$

The signs of the contributions to g_c and f_{12} will depend, therefore, on the signs and relative magnitudes of A and B. We cannot, therefore, agree with Coulson, Duchesne and Manneback that it is necessary "that the contributions to the interaction constants f_{12} and g_c that arise from the force between the two non-bonded atoms have the same sign". This will only be true when the first terms involving B, d^2V/dR^2, outweigh the second terms involving A, dV/dR. However, in the present case, it does not seem that the force between the non-bonded atoms is an important factor. Urey and Bradley[3] pointed out that this factor was important in accounting for the departures from the simple valency force-field in molecules such as carbon tetrachloride. We have developed their ideas somewhat further for the tetrahalides of some Group IV elements in two other papers that are awaiting publication[4], and have shown that the repulsion that exists is of the magnitude that would be expected if it arises from Van der Waals' type interaction.

D. F. HEATH
J. W. LINNETT

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Dec. 8.

[1] Coulson, Duchesne and Manneback, *Nature*, **160**, 794 (1947).
[2] Heath and Linnett, *Trans. Farad. Soc.*, in the press.
[3] Urey and Bradley, *Phys. Rev.*, **38**, 1969 (1931).
[4] Heath and Linnett, *Trans. Farad. Soc.*, in the press.

Spectral Response of Lead Selenide

MICRO-CRYSTALLINE layers of lead selenide are known to show photo-conductivity when illuminated by infra-red radiation, in a manner similar to that shown by lead sulphide. Measurements made in Germany during the War indicate that for lead selenide the long wave-length limit of sensitivity lies farther towards the far infra-red[1]. More recent experiments by Blackwell, Simpson and Sutherland[2] on the spectral response of lead selenide confirm this. Up to the present, however, the accurate determination of the long-wave limit has been impossible because of the very strong absorption in this region of the spectrum of 'Pyrex' and other glasses from which the photo-conductive cells have been made. We have recently developed a technique whereby a sensitive layer may be made in a cell with a window of *KRS5* material (a mixture of thallium bromide and iodide which has a uniform transmission of about 65 per cent from 1 to 35 μ).

The cell is made in an envelope of the usual Dewar flask type except that the outer wall is formed into an elongated neck opposite the layer electrodes, which are on the inner wall. Initially a layer of lead selenide is evaporated on to the electrodes *in vacuo*, and then the end of the glass neck is cut off, ground flat, and the window sealed on with vacuum wax. The layer is then treated by heating to a temperature just below its subliming point (about 405° C.) *in vacuo* for several hours. For this treatment the inside of the Dewar vessel is filled with a molten (low melting point) alloy maintained at the appropriate temperature by means of a small immersion heater. Finally, the layer must be recrystallized by evaporating on to the outer wall of the flask and then back on to the electrodes, when a sensitive, high-resistance layer is obtained.[3] Throughout these processes the window is kept cool by standing in cold water.

The accompanying diagram shows the spectral response of lead selenide for constant incident energy at 195° K. and 90° K. The shift to longer wave-lengths on cooling is analogous to that observed for lead sulphide[3]. Taking the flat portion of the curve as the datum-level, the response at liquid oxygen temperature is down to 50 per cent at 5·0 μ, indicating about 1·0 μ shift from the 195° K. curve.

The peak found at 1·2 μ is believed to be due to impurities and not inherently characteristic of the main lattice. At longer wave-lengths the response curve differs somewhat from that of other workers[1,2], who find a slight secondary peak. The presence of this peak may perhaps be connected with the varying transmission of the layer with wave-length. If the layer is too thin, all the incident energy is no longer absorbed at the longer wave-lengths, giving a false impression of the shape of the spectral sensitivity curve.

The layer which is the subject of this note was therefore made relatively thick (estimated as somewhat greater than 1 μ from the mass and area of the layer). Previous measurements in this laboratory have shown that layers appreciably thinner than this have considerable transmission in the region of 5 μ.

The spectrometer used was a double-dispersion instrument using lithium fluoride prisms and having a high degree of freedom from scatter.

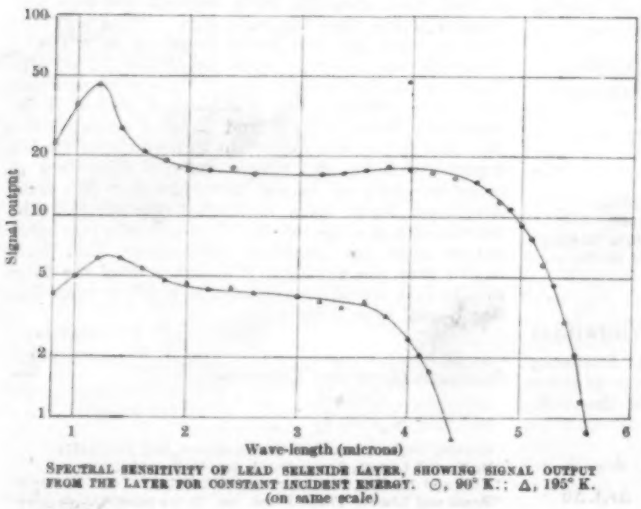
Our thanks are due to Dr. G. B. B. M. Sutherland and Mr. O. Simpson, of the University of Cambridge, for communicating to us, before publication, their method of making sensitive lead selenide cells[4] and their recent spectral response measurements[2]; also to the Ministry of Supply for permission to publish this letter.

T. S. Moss
R. P. CHASMAR

Physics Department,
Telecommunications Research Establishment,
Great Malvern.

Nov. 5.

[1] Elliot, "Electronics", chapter 3 (London: Pilot Press, 1947).
[2] Blackwell, Simpson and Sutherland, [*Nature*, **160**, 793 (1947)].
[3] Moss, *Nature*, **159**, 476 (1947).
[4] Simpson, [*Nature*, **160**, 791 (1947)].



SPECTRAL SENSITIVITY OF LEAD SELENIDE LAYER, SHOWING SIGNAL OUTPUT FROM THE LAYER FOR CONSTANT INCIDENT ENERGY. ○, 90° K.; △, 195° K. (on same scale)

Pinhole Radiography of Magnetrons

'PINHOLE RADIOGRAPHY' is extensively used[1] to study the size and shape of the focal spot of an X-ray tube. Where electrons strike the anode, X-rays are emitted in all directions; a camera, with a pinhole in a sheet opaque to X-rays in place of the lens, can be used to record an X-ray image of the bombarded area.

Hitherto, magnetrons[2] have operated at anode voltages too low for X-rays to escape from the tube envelope in appreciable intensity. We have recently been working on a high-power (2,000 kW.) pulsed 10 cm. magnetron, operating at 47 kV. anode voltage, 90-amp peak, 135-m.amp. mean anode current[3]. Having observed X-ray emission from this valve (10^{-5} r./sec. at 1 metre distance) we decided to make the following experiment.

The normal electromagnet gap of 8 cm. was increased to 11·5 cm., while maintaining the magnetic field at 1,600 oersteds. The valve was set up with one end-plate against a pole-face. A sheet of lead, 2 mm. thick, was placed against the other end-plate, and contained a pinhole situated on the axis of the valve.

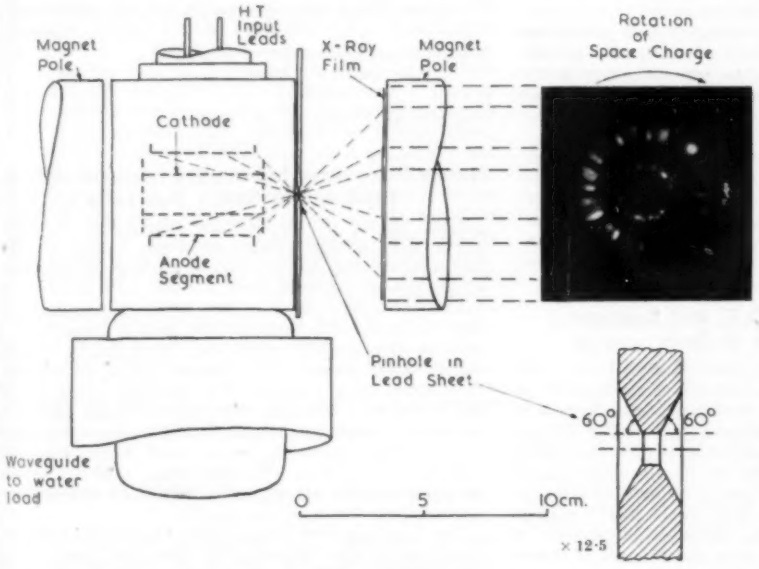
An X-ray film (Kodak 'Industrex' Type *D*) in a black paper envelope was pressed against the second pole-face. The general arrangement is shown in the figure, which includes a detail enlargement of the pinhole.

The accompanying radiograph is reproduced from a print of a negative obtained with a 10-min. exposure. The print shows bombardment of the following areas: (1) the 'far' end of the segments (small central ring of bright spots); (2) the 'near' end of some of the segments; (3) two or three of the spirally disposed 'echelon' strap wires at the near end; (4) limited areas on each segment between the near end and the middle.

The effects (1), (2) and (3) are thought to be incidental to the proper working of the magnetron. (Possibly they arise from the frequent flash-arcs taking place during the run.) On this view, (4) represents bombardment by the 'useful' electrons. It is of interest to note:

(*a*) Marked inequality of intensity on different segments.

(*b*) Concentration of bombardment on each segment in a line at the 'leading' edge and a patch near the 'trailing' edge.



(*c*) The apparent absence of bombardment near the middle plane of the valve, which may be due to increased absorption by the slant thickness (about 1 mm.) of the nickel cathode tube. (All rays recorded are filtered through the nickel end-disk of the cathode, 0·5 mm. thick, and 1·5 mm. of copper in the end-plate of the valve.) However, another exposure, with the pinhole eccentric to avoid absorption by the cathode tube of X-rays leaving the whole of two or three segments, showed no axial extension of the bombardment areas. The concentration towards the near end is perhaps due to the slightly weaker magnetic field near this end.

These first results already show that pinhole radiography can give valuable information about electron motion in magnetrons. We became aware of the value of pinhole radiography, in connexion with other high-voltage electronic valves, by learning of the prior experiments of Mr. A. G. Long[4], of Messrs. Newton and Wright, Ltd., on high-voltage rectifiers.

We desire to thank Mr. L. J. Davies, director of research of the British Thomson-Houston Co., Ltd., for permission to publish this note.

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Jan. 5.

[1] Herz, article in "Handbook of Industrial Radiography", 59 (London: E. Arnold and Co., 1944).
[2] Willshaw, Rushforth *et al.*, *J. Inst. Elec. Eng.*, Part IIIA, No. 5, 985.
[3] See ref. 2, Sect. 9, and Fig. 34.
[4] Forthcoming paper in *J. Inst. Elec. Eng.*

Latent Infection in *Coffea arabica* L.

Prof. S. R. Bose's article[1] dealing with the occurrence of *Phomopsis casuarinæ* F. Tassi throughout the tissues of *Casuarina equisetifolia* Forst. prompts me to record some observations made in 1940 and 1941 on the presence of various fungi in the tissues of Arabic coffee (*Coffea arabica* L.).

While investigating a disease of green coffee berries which is caused by a variety of *Colletotrichum coffeanum* Noack[2], healthy leaf, green berry, stem and pedicel tissues were tested for the presence of latent infections using a mercuric chloride–saponin solution as the surface sterilizing fluid. Practically every piece of tissue tested, down to one millimetre square pieces of leaf tissue, were found to produce fungal growth when cultured on prune agar. *Colletotrichum coffeanum*, in a large variety of forms, was most frequently obtained, but a species of *Phoma* and a species of *Phomopsis* were also frequently isolated. The fact that these fungi are present as latent infections on almost all healthy coffee tissue explains the constancy with which they fructify on tissues which have died from carbohydrate or nitrogen deficiencies, sun-scorch, etc., and explains why a number of physiological diseases have, in the past, been considered to be due to fungal attack.

The strains of *Colletotrichum coffeanum* isolated showed similar variations to those noted by Burger[3] for *C. glæosporioides* Penz. It was observed, however, that certain forms were most frequently isolated from certain parts of the plant. Those with short spores, sparse whitish mycelium and with the chlamydospores simple or absent were mainly found on twigs, whereas those with longer spores, abundant greenish mycelium and abundant convoluted chlamydospores occurred

most frequently on green fruits; intermediate forms were found mainly on leaves and pedicels. The form causing the disease of ripe berries, which is known as 'brown blight', is of this type, the extreme development of which is represented by the form which causes the serious disease of green berries known as 'coffee berry disease'. This form is characterized by the spores being produced separately on branches over the entire mycelium instead of being massed on stromata as with all the other forms. The forms on leaves and stems never appear to cause disease symptoms, though certain minute yellow spots on mature leaves may be due to the presence of the fungi. Fructification only occurs when the bark dies (perhaps somewhat prematurely) or the leaves are shed. It is interesting to note that the forms which make up the morphological series appear thus not only to be associated with different parts of the plant, but also with differing degrees of parasitism.

A similar series of forms appears to exist in the *Phoma* sp., again distinguished by increasing length of spores and by increasing coloration of mycelium. The individual forms also show a similar trend of preference for different parts of the plant. None, however, has been observed to produce a noticeably diseased condition. The *Phomopsis* sp., on the other hand, showed no obvious polymorphy.

There is some evidence to suggest that premature shedding of leaf, irregular bark ripening and uneven ripening of the berry may be associated with the development of the less pathogenic latent infection fungi in senescent tissues.

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Oct. 6.

[1] Bose, S. R., *Nature*, **159**, 512 (1947).
[2] McDonald, J., *Trans. Brit. Mycol. Soc.*, **11**, 145 (1926).
[3] Burger, O. F., *J. Agric. Res.*, **20**, 723 (1921).

Persistence of *D.D.T.* and Benzene Hexachloride in Soil

The use of 2 : 2-*bis*-(*p*-chlorophenyl)-1 : 1 : 1-trichlorethane (*D.D.T.*) and benzene hexachloride as soil insecticides raises the question of the length of time for which these substances will persist in soil. There is already much indirect evidence that both these substances are satisfactory in this respect; but the possibility exists that they may suffer bacterial[1] or other decomposition in soil, as do many organic compounds. So far as I am aware, this problem of persistence has not so far been the subject of direct chemical investigation.

In experiments commenced here some eighteen months ago, both *D.D.T.* and benzene hexachloride (mixed isomers containing 10 per cent gamma isomer) were incorporated at a high concentration (2 per cent) with acid and with alkaline soils. Treated and control soils were kept in the open, and the residual insecticide determined chemically at intervals. In view of the possibility that a decomposition in soil might involve dehydrochlorination, determinations were also made of soil chloride, chloride leached and *p*H.

Similar determinations were carried out in a second series of experiments in which soils kept under laboratory conditions were subjected to controlled leaching at intervals.

The results reveal the marked persistence of these insecticides under the conditions employed. Thus, even after eighteen months, more than 95 per cent of the *D.D.T.* and 80–94 per cent of the benzene hexachloride can be recovered. The chloride estimations on soils and leachings have not indicated the release of more than traces of inorganic chloride. No regular changes in *p*H have been observed.

Counts of soil bacteria, estimated by the plate method, suggest that neither *D.D.T.* nor benzene hexachloride has an adverse effect on the bacterial population.

While it is recognized that the concentration of insecticide used in these experiments is very considerably greater than would ever be used in practice, it is interesting to note that whereas the *D.D.T.*-treated soils permit normal germination and early growth of cress, oats and wheat, those treated with benzene hexachloride inhibit root development. Further, the benzene hexachloride soils do not permit root development in the case of sugar beet, cabbage and flax. Here the *D.D.T.* treatment results in a somewhat lower percentage germination, although early growth is then normal. Oats and wheat are particularly susceptible to benzene hexachloride, and suppression of the radicle occurs even when the concentration of this substance is reduced to 0·02 per cent by admixture with the control soil.

Details of this work will be published elsewhere.

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Oct. 29.

[1] Matthews, A., *J. Agric. Sci.*, **14**, 1 (1924).

Newly Discovered Submarine Canyons of New Guinea and South Australia

Fair charts of the Morobe area, New Guinea, which were recently made available to me by the Royal Australian Navy, show three huge depressions across the continental shelf. These are submarine canyons, apparently the first to be discovered off New Guinea. They extend to within less than a mile of the modern coast and their heads oppose outlets of the Rivers Gira, Eia and Waria, after which they have been named. The bottom gradients of the submarine canyons average up to 10 per cent across the continental shelf, which is about ten miles wide. They range to seven and eight hundred fathoms in depth at the shelf edge, and no details are known of the structures more than a mile or two beyond that limit.

The local sea floor is reported to be of soft volcanic muds, while coral growths line the shelf edge, rising from depths of from forty to seventy fathoms as barrier reefs. Minor coral growths occur at intervals along the submarine canyon rims. On the assumption that reef corals do not flourish in water deeper than about 20–30 fathoms, it is inferred that sea-level fell relatively by at least 40–50 fathoms at the time of barrier reef establishment. Unfortunately, nothing is known accurately of local land movements during the interval of canyon formation.

In keeping with Daly's theory[1] of submarine canyon development, which holds that muddy bottom density currents eroded the canyons during low sea-level periods of the Pleistocene, it is considered that canyon development proceeded contemporaneously with barrier reef establishment. However, in the present case, evidence suggests that submarine canyon erosion was initiated by silt-laden river waters entering the sea locally during the low

sea-level phases, rather than simply by shore wave action on exposed continental shelf sediments. If the latter process was widely developed, it is thought that barrier reef establishment would have been inhibited or prevented. A possible counter to this argument, namely, that the muddy fraction of the shelf edge sediments would have been winnowed out during the early part of a low sea-level stand, is weakened by the fact that it would reduce the time interval of effective erosion by such inferred shore suspension currents too greatly.

Of the Murray submarine canyons, off the South Australian coast, little is yet known. They were located by the naval survey vessel H.M.A.S. *Lachlan*, by tracing the 100-fathom line for about eighty miles in the vicinity of the Murray River mouth. The deep submarine canyon structures occur in a width of less than four miles, although the remainder of the survey course revealed no other significant break.

The submarine canyons are thought to be genetically related to drowned courses of the Murray River, which is the only large river at present entering the sea locally. Along the line of the echo-sounding traverse, the three structures, named respectively the West, Central and East Murray submarine canyons, bottomed at approximately 550, 625 and 750 fathoms. The central and east members are separated by a low but definite ridge.

It is not known whether the three submarine canyons are essentially parallel structures or part of an elongated dendritic pattern. Investigations to be carried out in the future should solve this problem.

Concerning canyon triplicity, in a paper on the two groups of submarine canyons now in the press[2], I have advanced two theories as alternative possible explanations. Both relate to the repeated sea-level falls of the Pleistocene glacial phases, during which erosion by means of bottom density currents is considered (Daly's theory) to have been at a maximum.

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Oct. 15.

[1] Daly, R. A., "The Floor of the Ocean" (Univ. of North Carolina Press, 1942).
[2] Sprigg, R. C., *Trans. Roy. Soc. S. Aust.*, in the press.

Units and Useful Range in Photo-electric Colorimetry

WE value the remarks of Drs. Edisbury, Taylor and Gridgeman[1] on a new unit in photo-electric colorimetry[2]. Opinions do not seem at variance that measurements should be made at approximately the same optical density[1,2], that—provided the Beer–Lambert law be valid—the relation of the proposed unit $W^{50}_{1\,cm.}$ to the usual $E^{1\%}_{1\,cm.}$ can be expressed by:

$$E^{1\%}_{1\,cm.} = \frac{0{\cdot}00301}{W^{50}_{1\,cm.}},$$

and that E (1%, 1 cm.) is certainly less cumbersome to print than $E^{1\%}_{1\,cm.}$. Title and text of our letter[3], however, should have made it clear that we had photo-electric colorimeters (absorptiometers) in mind. Though it was shown by Twyman and Lothian[3] that 0·4343 is the best density for this type of instrument, it was also stated that ". . . we may use densities between 0·2 and 0·8 without any considerable loss of accuracy". This range covers easily the proposed half-value and adjacent auxiliary readings used for interpolating $W^{50}_{1\,cm.}$. An even wider range (0·2–1·2) is recommended elsewhere[4] for an instrument other than ours. The statement[1] that E (1%, 1 cm.) is merely a standard expression that does not carry the implication that one must measure the optical density of a 1 per cent solution in a 1 cm. cell may probably be correct, but not necessarily so, and does not seem to be endorsed unanimously; for Guild[5] inferred regarding accuracy in spectrophotometry that ". . . our terminology should be kept in as close correspondence as possible with the physical magnitudes actually handled in our experiments", strongly deprecating the use of derived magnitudes. Though the proposed half-value is inversely related to quantity, this need not impair its applicability; for a similar magnitude, the half-value layer is a standard expression in X-ray technique[6].

Thus the major practical point in dispute seems to be, how far the useful range extends towards both ends of the scale. As many extraneous factors influence the final accuracy, the limits of the useful range have to be established by experiment. To test this, sample and blank are compared, say, twenty times, whence a mean and its standard deviation are obtained. From the mean plus/minus sigma, and from the Beer–Lambert law, the error prevailing at this point of the scale can be estimated. A few pilot measurements towards either end of the scale will readily establish fiducial limits. 920 measurements performed on different concentrations of copper sulphate in water did not reveal any significant difference in accuracy between 10–90 per cent transmission. Within this range, two thirds of all observations fell within the limits $\pm$ 0·88 per cent weight of copper sulphate. The corresponding error below and above this range was 2·60 per cent and 2·56 per cent respectively.

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DEBORAH KAPLAN

Department of Hygiene,
Hebrew University,
Jerusalem.
Nov. 3.

[1] Edisbury, J. R., Taylor, R. J., and Gridgeman, N. T., *Nature*, **159**, 777 (1947).
[2] Koch, W., and Kaplan, D., *Nature*, **159**, 273 (1947).
[3] Twyman, F., and Lothian, G. F., *Proc. Phys. Soc.*, **45**, 643 (1933).
[4] Glover, J., Goodwin, T. W., and Morton, R. A., *Biochem. J.*, **41**, 97 (1947).
[5] Guild, J., *Proc. Phys. Soc.*, **45**, 659 (1933).
[6] Pohle, E. A. and Chamberlain, W. E., "Theoretical Principles of Roentgen Therapy" (Lea and Febiger, Philadelphia, 1938).

THE major practical point in dispute is not "how far the useful range extends towards both ends of the scale" (though we believe this to be narrower than many published figures imply), but whether the proposed new unit fulfils any useful function not already covered by the old; and on this issue we have nothing to add to our original arguments. We would ask only that anyone who still prefers to use the 'half-value' should also, for the convenience of the reader, give the equivalent E (1%, 1 cm.) value.

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HIGH-ALTITUDE MEASUREMENTS ON COSMIC RAYS

Penetrating Cosmic Ray Showers

THE penetrating shower set *P*, described in a previous communication[1], has now been transported to the Scientific Station, Jungfraujoch, altitude 3457 metres (atmospheric pressure = 50 cm.), and the transition curves of penetrating showers, produced in paraffin, aluminium and lead placed over the set *P*, studied there. In addition to the apparatus illustrated in our earlier note, four unscreened trays of counters, $E_1 \ldots E_4$, of areas 230, 460, 920 and 1,840 cm.^{2} respectively, were placed near the penetrating shower set, *P*, for recording the presence of air showers. Also the side and end screens of the set, *P*, were increased from 10 cm. to 15 cm. of lead. The seven-fold coincidences of *P* were recorded and, in addition, coincidences in *P* accompanied by a discharge of each of the four air-shower trays were recorded separately.

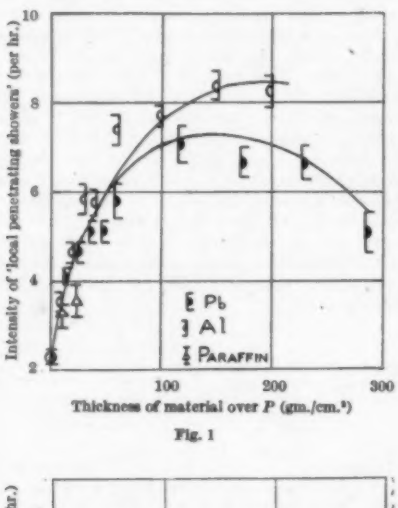


Fig. 1

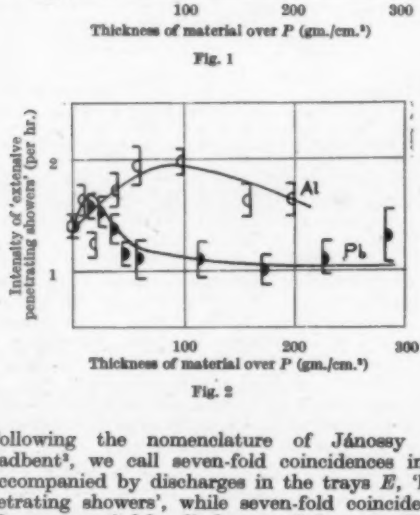


Fig. 2

Following the nomenclature of Jánossy and Broadbent[2], we call seven-fold coincidences in *P*, unaccompanied by discharges in the trays *E*, 'local penetrating showers', while seven-fold coincidences in *P*, accompanied by discharges of the trays *E*, are defined as 'extensive penetrating showers'. The importance of distinguishing between these two types of penetrating shower is illustrated by the work of Jánossy and Broadbent[2], who have shown that the intensity and transition curves for local penetrating showers are consistent with the view that they are caused by nucleons of the primary cosmic ray flux arriving on the top of the atmosphere. The interpretation of extensive penetrating showers is not so unambiguous at the moment. We discuss our results for these two types of shower separately.

(*a*) *Local Penetrating Showers.* The transition curves obtained for these showers are shown in Fig. 1, where the abscissæ give the thickness of different materials expressed in gm./cm.^{2}. It will be noted that initially the results all lie on the same curve, the results for lead and aluminium differing slightly for the largest thicknesses studied. This divergence is possibly due to the geometrical difference in the arrangement of the absorbers placed over *P* caused by the difference in density of the two substances. An attempt was made to counteract this density effect by spacing out the lead, but it is not possible to compensate exactly.

A comparison with the sea-level results of Jánossy and Broadbent shows that the intensity at Jungfraujoch is 28 times the sea-level intensity, which corresponds to a range of the primaries causing them of 120 gm./cm.^{2}, and this again is consistent with the primary nucleon hypothesis.

(*b*) *Extensive Penetrating Showers.* The transition curves for extensive penetrating showers, measured using the tray E_4, is shown in Fig. 2, plotted on the same mass-scale as Fig. 1. It will be noted that these transition curves are typical cascade curves.

The intensity of this type of shower is only 10 times the sea-level intensity, and this is consistent with the increase of 12 in the intensity of air showers recorded by Auger at this same station.

E. P. George
A. C. Jason

Nov. 8.

[1] George and Jason, *Nature*, **160**, 327 (1947).
[2] Jánossy and Broadbent, *Proc. Roy. Soc.*, A, **190**, 497 (1947).

Penetrating Bursts

MEASUREMENTS at sea-level on the existence of penetrating particles in ionization bursts have already been briefly reported[1]. We have now constructed an apparatus more sensitive to this type of burst, and after a short run at sea-level have carried out measurements on penetrating bursts at the Scientific Station at the Jungfraujoch.

The apparatus is illustrated in Fig. 1. An aluminium ionization chamber *B*, of 1·5 litres capacity and of wall thickness 1·25 cm., was filled with pure argon to a pressure of 30 atmospheres. Above and below the chamber were placed cylindrical screens of lead *A* and *D*, of thickness 15 cm. or greater, as shown. Furthermore, the ends were closed by lead screens of thickness 12 cm. In the lower screen *D* is a concentric slot *E*, in which were placed eighteen Geiger–Müller counters. Similarly, under the ionization chamber 9 Geiger–Müller counters *C* were placed, divided into three groups of 3, as shown. Further, the screens were flanked on each side by trays of counters I, II, III, IV, for the detection of air showers. These air-shower trays consisted of 1, 2, 4 and 8 counters respectively, each counter being of area 230 cm.^{2}.

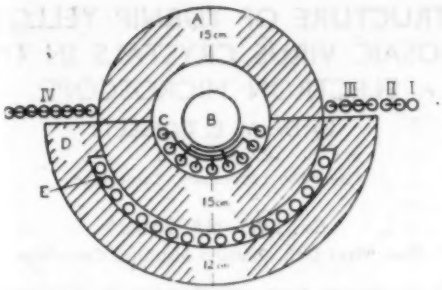
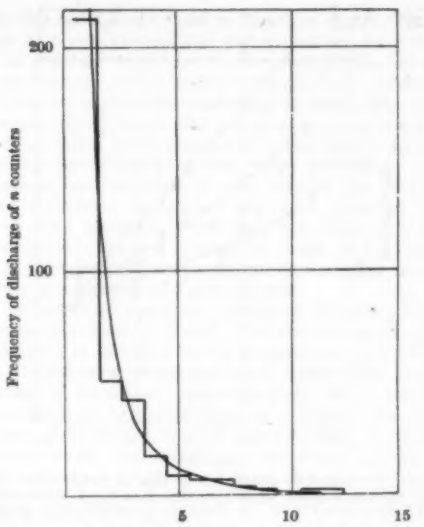


Fig. 1. General arrangement of apparatus

The voltage impulses produced by bursts of ionization in the chamber were amplified and recorded by a continuous camera, in a normal manner. To each of the lower counters 1 . . . 18 in E, and the air-shower trays I . . . IV, lamps were connected via separate amplifiers, and a given lamp was energized if a burst occurred accompanied by a three-fold coincidence in the upper counters C, plus a discharge in the corresponding counter to which it was connected.

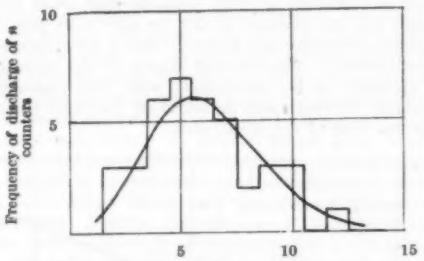
From separate control experiments, it was shown that the majority of bursts accompanied by a discharge of only one of the lower counters was due to accidental coincidences, whereas those bursts accompanied by a discharge of more than one lower counter could not be so. Bursts accompanied by a discharge of more than one lower counter will be defined as 'penetrating bursts'. In the same way that Jánossy and Broadbent[2] showed the importance of distinguishing between so-called 'local' and 'extensive' penetrating showers, so we find it convenient to separate penetrating bursts into those associated with air showers, which we shall call 'extensive penetrating bursts', and those penetrating bursts unaccompanied by a discharge in the air-shower trays I–IV, which we shall call 'local penetrating bursts'. The fact that these two types of penetrating bursts are essentially different is shown in Figs. 2*a* and 2*b*, in which the frequency of discharge of n of the lower counters is plotted against n for local and for extensive penetrating bursts, observed in a period of 120 hours. While the size distribution for local bursts varies approximately as $1/n^3$, the size-distribution for extensive bursts seems to be given approximately by the Poisson distribution for $\bar{n} = 5$ or 6.

The intensities of the various types of burst are given in the table:



No. of counters discharged simultaneously (n). Smooth curve, $1/n^3$

Fig. 2*a*. Local bursts



No. of counters discharged simultaneously (n). Smooth curve, Poisson distribution, $\bar{n} = 6$

Fig. 2*b*. Extensive penetrating bursts

Type of burst	$R(>N)$ = Rate/hour of bursts of size $> N$							
	N							
	20	30	40	60	80	100	150	200
All bursts	12·6±0·34	3·52±0·18	1·81±0·13	0·89±0·06	0·41±0·06	0·25±0·05	0·11±0·03	0·095±0·03
Penetrating bursts	1·56±0·12	0·71±0·08	0·48±0·07	0·33±0·06	0·16±0·04	0·12±0·03	0·10±0·03	0·076±0·03
Extensive penetrating bursts	0·31±0·05	0·20±0·04	0·11±0·03	0·10±0·03	0·095±0·03	0·085±0·03	0·085±0·03	0·066±0·025

These results are plotted on logarithmic scales in Fig. 3. The slope of curve (1) for all bursts is $-2{\cdot}2$, giving $R(>N) = \text{const.}\ N^{-2\cdot2}$, whereas the size contribution for penetrating bursts is quite different. It will be noted that of the largest bursts measured ($N>200$), the majority are penetrating and also extensive. The increase of burst intensity over the sea-level figure is a factor of 3·9, and this is about the amount by which penetrating bursts have increased with altitude.

Penetrating bursts thus show much less of an increase with altitude than do penetrating showers[3], and we can therefore eliminate the nucleon component as the primary agent of penetrating bursts.

The interpretation of local penetrating bursts is perhaps the simplest. We have divided up these bursts into groups of different size, and measured the total number of lower counters discharged by bursts in the various groups. In Fig. 4 we have plotted the number of counters discharged per local penetrating burst as a function of the mean burst size of the group.

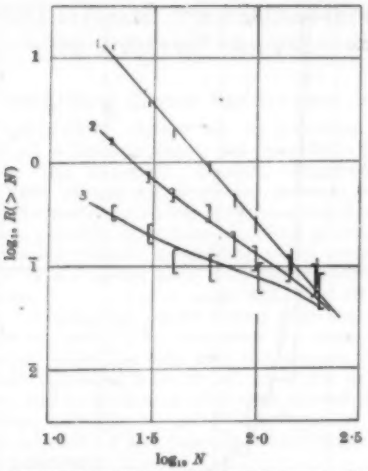


Fig. 3. INTENSITY OF BURSTS. N IS SIZE OF BURST; $R\ (>N)$ IS RATE/HOUR OF BURSTS OF SIZE GREATER THAN N. 1, ALL BURSTS. 2, PENETRATING BURSTS. 3, 'EXTENSIVE' PENETRATING BURSTS

The relation appears to be linear, and on the average one counter is discharged per local burst of 130 rays. The efficiency of collection of the lower tray is about ½, and it therefore appears possible that local bursts contain on the average 3/130, or about 2½ per cent of mesons, and are apparently caused by mesons.

The extensive penetrating bursts would appear on the average to be associated with the passage of something like eighteen penetrating particles through the lower half of the apparatus.

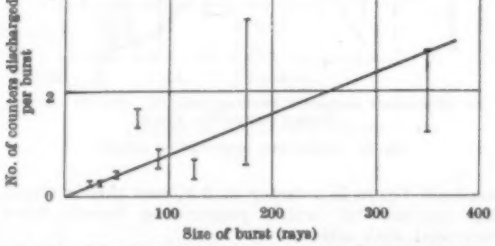


Fig. 4. VARIATION OF NUMBER OF COUNTERS DISCHARGED BY 'LOCAL PENETRATING BURSTS'

It would appear that additional processes are involved in burst production, under thick lead, over and above the creation of high-energy electrons and photons by mesons, and the subsequent cascade development of the former. For bursts of size greater than 100, these additional processes are involved in a large fraction of bursts, and this would appear to invalidate the arguments put forward for assigning the value 0 to the spin of the cosmic ray meson[4], based on measurements of burst production under thick materials.

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P. T. TRENT

Birkbeck College,
University of London.
Nov. 12.

[1] George and Jánossy, *Phys. Rev.*, **70**, 773 (1946).
[2] Jánossy and Broadbent, *Proc. Roy. Soc.*, A, **190**, 497 (1947).
[3] George and Jason, see previous communication.
[4] Christy and Kusaka, *Phys. Rev.*, **59**, 414 (1941).

STRUCTURE OF TURNIP YELLOW MOSAIC VIRUS CRYSTALS IN THE ELECTRON MICROSCOPE

By DR. V. E. COSSLETT
(I.C.I. Fellow)
Cavendish Laboratory, Cambridge
AND
DR. ROY MARKHAM
Plant Virus Unit, Molteno Institute, Cambridge

IT is known from examination in the electron microscope that turnip yellow mosaic virus[1] consists, in the dry state, of individual particles of spherical form and about 22 mμ in diameter. It readily forms macroscopic crystals, usually octahedra, from aqueous salt solutions. Preliminary X-ray studies indicate that these wet crystals have a large unit cell, and Carlisle suggests[2] that the lattice may be of the diamond type. Attempts have been made to obtain replicas of the dry crystals, by the method which has proved successful with some other plant viruses[3,4], but these have not shown any regular structure. The failure may be due to the shape of the crystals or to difficulties of drying.

Electron micrographs have been taken (by transmission) of the virus mounted on beryllium films, and some of them show a number of micro-crystals having the appearance of a net formed by hexagonal rings (Fig. 1). Each ring has an electron-transparent hole in the centre, of such a size that the rings appear larger than the size of the individual virus particles. From the photographic density of the images, it may be estimated that the crystalline fragments are only a few molecules thick in the direction of the electron beam. The fainter patches' in the background also show similar structure in some regions, and may be only two or three molecules deep.

As the electron micrographs seemed to agree with a diamond-type lattice, measurements were made on the hexagonal network in various directions. The

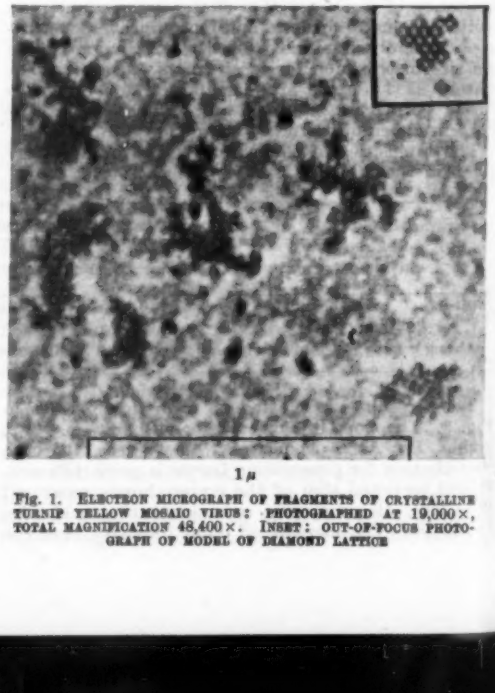


Fig. 1. ELECTRON MICROGRAPH OF FRAGMENTS OF CRYSTALLINE TURNIP YELLOW MOSAIC VIRUS: PHOTOGRAPHED AT 19,000×, TOTAL MAGNIFICATION 48,400×. INSET: OUT-OF-FOCUS PHOTOGRAPH OF MODEL OF DIAMOND LATTICE

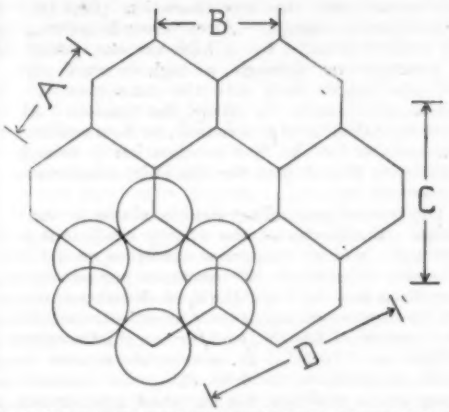


Fig. 2. PROJECTION OF DIAMOND-TYPE LATTICE, VIEWED NORMAL TO 110 FACE

measurements were made easier by the fact that the crystalline regularity extended in places as far as 150 mμ, although in other places there was obvious distortion. Prints of the negatives were made on process plates, and these were projected at a final magnification of 186,500 times on to paper. The centres of the holes were marked, and measurements made with a ruler, the distances between 146 pairs of holes being measured in all. The measurements were made in four principal directions inclined to each other (*A*, *B*, *C*, *D*, in Fig. 2), and suggest that the pattern is not a regular hexagonal one, since for the latter $A = B$ and $C = D$. They do, however, agree well with the hypothesis that the crystal is of diamond type, viewed normal to the 110 face, along the diad axis. The measurements are tabulated in Table 1.

TABLE 1

Axis	Average distance (mm.)	No. of holes measured
A	5·18	42
B	5·40	56
C	8·60	35
D	9·67	13

From the known relative values for the dimensions *A*, *B*, *C* and *D*, the theoretical spacings fitting the above data were calculated by the least squares method and are given in Table 2 in units of the diameter of the particles composing the lattice, assuming them to be rigid spheres.

TABLE 2

Axis	Theoretical value	Value calculated from experimental data
A	1·41	1·44
B	1·63	1·50
C	2·31	2·40
D	2·74	2·70

A photograph of a model of the diamond lattice, taken out of focus to correspond with the lack of resolution of the electron micrograph, has been superimposed on Fig. 1 in order to give a visual comparison of the observed and postulated structures.

The size of the rigid spherical particle best fitting the data is 19·5 mμ in diameter. As the dry virus has a density of 1·45, the molecular weight is about $3{\cdot}5 \times 10^6$. These figures compare with the value of 22 mμ for the diameter, obtained from electron micrographs of individual dry particles and by other methods[5], and with the value of 30 mμ suggested by the X-ray evidence and 28 mμ from the diffusion constant, the latter two values referring to the particles in the wet state. On the basis of these values, the water content by volume of the crystals would be 84 per cent, compared with 62 per cent for bushy stunt virus crystals. However, the formation of a diamond-type lattice, instead of a close-packed type, by the turnip yellow mosaic virus would indicate the existence of tetrahedrally directed bonding forces between the virus particles. It is therefore possible that in the crystal the particles suffer distortion compared with the spherical form which they probably (although not certainly) have in isolation. Such a change in shape in the lattice would allow a smaller water content than that derived on the assumption of rigid spheres.

The beryllium films were prepared according to the method described by Hast[6]. One droplet of the virus suspension in distilled water is placed on a collodion film carried on a nickel specimen grid. After drying, a layer of beryllium approximately 50 A. thick is evaporated on to the surface in a highly evacuated bell-jar. Immersion in pure amyl acetate or acetone dissolves away the underlying collodion, leaving the virus supported by the beryllium alone on the nickel grid. The original micrographs were taken at a magnification of 15,000.

Attempts to observe similar crystals by drying the virus on pre-formed films of beryllium have so far yielded no unambiguous result, although fragments of the same general shape as shown in Fig. 1 are frequently obtained; they are, however, not resolved into molecular structure. It is probable that the evaporation method of making the beryllium film results in an accentuation of contrast in the specimen, the deposited film having a slightly greater thickness to the beam where it is inclined to the plane of the collodion substrate; a similar effect gives rise to contrast in silica replicas of surfaces. It may also be that beryllium atoms reaching the surface are mobile on it for a short while, and aggregate preferentially along edges. Similar preparations of tomato aucuba mosaic virus show such an accentuation of the sides of rods and rod-aggregates (Fig. 3). When this virus is settled on to preformed beryllium films, however, no

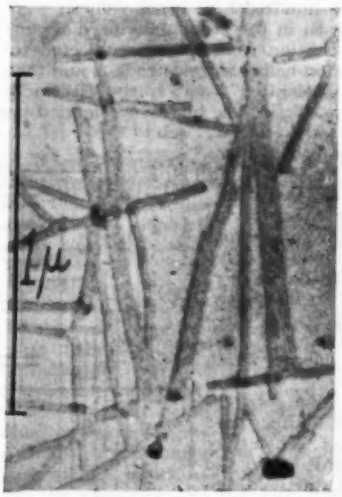


Fig. 3. ELECTRON MICROGRAPH OF TOMATO AUCUBA MOSAIC VIRUS PARTICLES ON BERYLLIUM SUPPORTING FILM: PHOTOGRAPHED AT 16,000×, TOTAL MAGNIFICATION 51,600×

trace is visible of this effect, making it clear that the particles are not hollow in the centre, as might be inferred from Fig. 3.

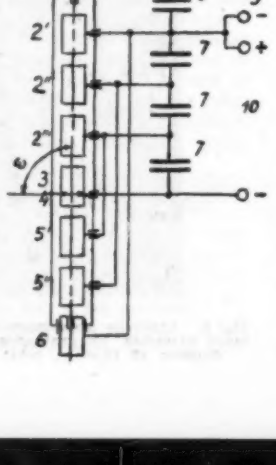
Beryllium films allow much clearer micrographs to be obtained of virus and similar particles than when they are carried on collodion films, owing to the greater background scattering given by the latter. Particle-size determination is thereby made more accurate, especially when side-by-side aggregations are obtainable, as in Fig. 3. It is observed, however, that the virus exposed to the electron beam rapidly becomes clouded over and all definition is lost in a few minutes. It is probably as much due to this effect as to the greater background scattering, that the lattice structure in crystalline fragments of viruses has not previously been observed with collodion-supported preparations. The nature of this contamination has been discussed elsewhere[7].

[1] Markham, R., and Smith, K. M., *Nature*, **157**, 300 (1946).
[2] Carlisle, C. H., private communication.
[3] Price, W. C., and Wyckoff, R. W. G., *Nature*, **157**, 764 (1946).
[4] Markham, R., Smith, K. M., and Wyckoff, R. W. G., *Nature*, **159**, 574 (1947).
[5] Unpublished data.
[6] Haas, N., *Nature*, **159**, 354 and 370 (1947).
[7] Cosslett, V. E., Electron Microscope Conference, Leeds, Sept. 1947, in the press.

DISCHARGE TUBE FOR NUCLEAR REACTIONS WITH IMPROVED YIELD

IN an article on a "Dischargé Tube for Nuclear Reactions with Improved Yield" (*Elektrotechnický Obzor* (Prague), **36**, No. 14, 266; 1947), I have described a new discharge tube which, besides giving a better yield and minimized target heating, has the advantage that the acceleration of the particles is effected in two stages: acceleration by means of 100-300 kV. with a current consumption of the order usual for normal discharge tubes using 1–2 MV., and a following principal acceleration by a tension of some megavolts with a current consumption less than five hundredth of usual values.

As shown in the accompanying diagram, particles leaving the ion source 1 are subjected to the first acceleration before the electrode 2, and then they are highly accelerated between the electrodes 2′, 2″; 2″, 2‴; 2‴, 3. The highly accelerated particles go through the target, which is 5×10^{-4} cm. thick. Only a small number of them produce nuclear reactions or are diverted from their direct paths. Through the scattering by electrons, the other particles give up that part of their kinetic energy which they have obtained by the first acceleration, and thus heat the target. Then they are retarded into the electrostatic field between the electrodes 3, 5′; 5′, 5″; 5″, 6 to such a degree that they enter into the recombination place 6 with little kinetic energy. After recombination, they are sucked from 6 by a high-vacuum pump into a reservoir or through a high-vacuum pipe of sufficient length back into the ion-source 1. The condensers 7 serve to divide the tension. At the same time they hold it constant, as does condenser 8. The tension for the first acceleration is brought to connectors 9 and that for the chief acceleration to connectors 10.



The greater part of my article relates to the theoretical calculations of the energy conditions in the new tube, and six numerical examples are provided. In order to produce 10^{11} neutrons per second from beryllium 5×10^{-4} cm. thick by deuterons, we need for the first acceleration the current-intensity 800 μA. at a tension of 300 kV., and for the chief acceleration 0·28μA. at 2·70 MV. If we raise the tension for the chief acceleration to 9·90 MV., the current consumption is 0·016μA. for the chief acceleration and 800μA. at a tension 100 kV. for the first acceleration. In the usual discharge tubes with a massive target, we need under the same conditions a current intensity not less than 150μA. at 3 MV. and not less than 16μA. at 10 MV.

Thus the reduction of current consumption for the chief acceleration is very considerable. Also the target heating is minimized. In spite of this, its cooling (by radiation) is the most difficult problem of the new tube. This point will probably decide whether it will be advantageous to construct the tube.

The principal idea of the new tube, namely, to regain the kinetic energy of the highly accelerated particles by means of retardation in the electrostatic field, can be used with great advantage in the construction of other tubes for nuclear physics. In those, and not in the tube discussed, lies the practical use and importance of the scheme.

JAROSLAV PACHNER

WAR-TIME RHEOLOGICAL INVESTIGATIONS FOR THE BRITISH ARMED SERVICES

A GENERAL meeting of the British Rheologists' Club was held at the Royal Society of Arts on December 17, when papers on war-time rheological investigations were read by Dr. A. S. C. Lawrence (Navy), Mr. A. G. Ward (Army) and Dr. E. W. J. Mardles (Royal Air Force). Dr. A. S. C. Lawrence spoke on the experiments done subsequent to the lecture on rheology and Naval problems by Sir Charles Goodeve in 1943 ("Essays in Rheology", Pitman, 1947), and by means of photographs he described the icing of ships in the North Atlantic and methods employed for de-icing. Dr. Lawrence continued with the problem of sea-water – fue emulsions and fundamental work carried out in con nexion with it.

Mr. A. G. Ward spoke on researches carried out with regard to the elasticity and plasticity characteristics of various propellants and of methods of rheological measurement involved, including those of resonance and penetration. Dr. E. W. J. Mardles mentioned rheological problems involved in the high-speed and high-altitude flight of aircraft, when temperatures so low as − 80° C. are sometimes reached, with consequent development of tendency in

materials to fracture. Methods of measurement of the consistency of greases and lubricants at low temperatures had been worked out and were briefly described.

Mr. A. de Waele (in the chair), in opening the discussion, remarked on the wide range of problems dealt with successfully by the rheologist; among the subjects discussed by the meeting were the dispersion phenomena of cellulose derivatives in organic media, the movement of spheres in emulsions and non-Newtonian liquids in general (Stokes' law is not usually applicable), rigidity-thixotropy, and the penetration of clays and other soft solids by piles and other penetrometers. Dr. A. W. Skempton described some recent experiments on clay movement, supporting the findings of A. S. C. Lawrence that the movement of a droplet in a fuel – sea-water emulsion is accompanied by vortex movement extending to at least ten diameters, and of E. W. J. Mardles that similar movements have been observed in thickened liquids during penetration by spheres, disks, rods or cones. The general movement over a wide range of the system, such as when a grease is penetrated by a solid body, may account for the finding of E. W. J. Mardles that the volume displaced by a penetrometer of given weight over a period of time is more or less independent of the shape, and characteristic of the material.

SOCIAL STUDIES OF THE ELDERLY

By ELEANOR FRENCH

IT is interesting to watch the emphasis slowly shifting in the sphere of social welfare to the elderly and their needs and problems, as the relentless march of time forces the effects of our ageing population upon our notice. In 1901 there were 2,408,426 persons in Great Britain over sixty years of age; in 1946 there were 6,587,000 [1], and the assumption in the Beveridge Report is that by 1971 there will be 9,576,000 men over sixty-five and women over sixty in Britain[2].

The two extremes of life thus assume a new importance, and the increasing claims of the ageing must not be met at the expense of the young; but to say this does not mean that those claims should be ignored. The publication of "Old People" by the Trustees of the Nuffield Foundation[3] earlier in the year aroused much interest; this has been followed by a further survey of a particular district: "Old People's Welfare on Merseyside"[4], and in June the British Medical Association published a report on the care and treatment of the elderly and infirm. These three documents give a clear picture of the present conditions in which the elderly are living and make recommendations for improving and supplementing them.

One of the most urgent needs for them (as for everyone else) is better housing: there appears to be little question that old people are badly underhoused, and according to Dr. Elsas[5], in 1939, given a ratio of forty dwellings per hundred adults, the 3·7 million persons over sixty-five should have had 1·5 million dwellings; but there were actually at that time only half a million dwellings in England and Wales consisting of one or two rooms. Conditions have certainly not improved since then, and the Nuffield Survey[3] recommends "that 5% of the houses in any community should be such as are suited to the special needs of old people. . . ."

But though 95 per cent of old people live in private houses[3], the remaining 5 per cent live in institutions, whether public or private, and here, too, conditions are often unsatisfactory. Institutions under the local authority are often vast old-fashioned 'barracks': for example, in four of these institutions in Liverpool and Birkenhead on one night in February 1946 there were 2,312 [4] old people of pensionable age: "The sight of a dining room seating 300, a huge dormitory with 110 beds . . . is most depressing"[4]. Old people and children seem to need very similar conditions for their welfare and happiness, and the Report of the Curtis Committee regards large institutions as quite unsuitable for young children also. It is good news that local authorities, or rather 'welfare authorities' as they will be called, have been given power to establish special homes for the aged to house between twenty and thirty.

Adequate medical aids, another pressing want of the aged, will be available under the new National Health Service. When these and other material needs have all been met, there still remain those of the spirit, for old age is apt to bring loneliness, a sense of uselessness, and boredom. Much could be done to remedy these: Dr. Vischer, for example, at Basel, has his homes for the aged attached to the municipal hospital, and their inmates are offered, if they wish, suitable types of work in the clinics and dispensary, for which they are paid a small fee[6]. Such a scheme encourages the old people and gives them a sense of still being useful members of a community, and at the same time it helps the hospital to solve its staff problem. Old age tends to isolate the individual from the main stream of life, but at the same time full utilization of his remaining powers is needed for the benefit of the community of which the aged form an increasing part.

[1] Registrar General's figures.
[2] Report of the Committee on the Care and Treatment of the Elderly and Infirm, *Brit. Med. J.* (June 21, 1947).
[3] "Old People" (Nuffield Foundation).
[4] "Old People's Welfare on Merseyside" (University of Liverpool, Social Science Department).
[5] Elsas, M. J., "Housing and the Family", 91.
[6] Vischer, A. L., "Old Age".

FUEL ECONOMY IN SWITZERLAND

THE World Power Conference is issuing reports on war-time fuel-saving methods in many States. Obviously these differ widely.

The problem in Switzerland* was given a particular interest by clear-cut circumstances and limitations. That country lacks substantially all native solid or liquid fuel resources except wood, and this plays an insignificant part. The only freely available source is hydro-electric power, and this provides only a minor part of the need. Furthermore, it is essentially seasonal in supply, being dependent on the variable flow of streams. Summer is the principal season for the production of water-power, whereas winter is the time when power is in greatest demand. Available storage facilities are inadequate to compensate for this disparity. At most, available water-power provides for the needs for lighting and motive power,

* Reports on Fuel Economy since 1939. Swiss National Committee. Pp. 20. (Central Office of World Power Conference, 201–202 Grand Buildings, Trafalgar Square, London, W.C.2.) 1s. net.

but by no means for heating or the industrial demands for electrothermal and chemical needs.

The experience of the First World War stimulated the development of hydro-electric resources and the use of electricity for railways, lighting, power and special heating, where it offered a preponderating advantage. It could only be used in summer for general heating and for electrochemical or electro-metallurgical purposes. By 1938, 98 per cent of the railway traffic was electrically operated, but electricity provided 5 per cent only of the total supply of thermal energy. Three-quarters of the heat was supplied by imported coal. Moreover, between 1913 and 1938 the consumption of coal altered little. There was only a change in the distribution of the load.

When war broke out in 1939 it was not surprising that rationing became drastic and realistic. All production of electricity by fuel-fired boilers—except back-pressure units—was suspended. Coal was allocated according to priorities. Domestic heating, which in 1938 absorbed 50 per cent of the imports of coal, was 'mercilessly' cut to nil in 1943–44, and gas to 21 per cent in 1945–46. In winter, electricity would be prohibited for space heating, water heating and steam generation, these being termed 'low-efficiency uses' of electricity. Industrial coal-fired boiler plant offered little scope for fuel saving, owing to the high efficiencies current in peace-time. To meet the high cost of fuel, boiler efficiencies of 75–80 per cent were the rule, even in small plants. Figures such as these are uncommon in Great Britain.

In conclusion, the report says that in spite of the abundance of water-power, half of which is already developed, Switzerland remains dependent on imported coal. There need be no illusions of its replacement by hydro-electric power. The supply of electricity is limited by natural causes. Its proper application is the supply of power, and in winter its use for low-grade heating is not encouraged.

NEW ITALIAN COSMIC RAY LABORATORY

A NEW high-altitude research laboratory for cosmic ray work at a height of 11,500 ft. on the upper slopes of Monte Rosa was opened by the Italian Centre for Research in Nuclear Studies on January 11. The laboratory portion of the station at present consists of one large experimental room, and a small fully screened room for a Wilson cloud chamber. The equipment is very complete, and includes a three-phase 30 kW. power supply, a separate lighting supply, and two high-capacity battery sets with a petrol generator in case of main power failure. The station is also equipped for two-way direct radio contact with the parent laboratory at Rome, a useful facility at all times, but particularly necessary when the Laboratory is likely to be cut off from the outside world for days at a time in mid-winter.

The Laboratory is situated on an exposed ridge on the Italo-Swiss frontier, and is actually half in Switzerland. It is served by a cable railway, which —under normal weather conditions—runs from Breuil (Cervinia) in the valley, 4,500 ft. below. Breuil is itself connected with the rail-head at Chatillon by a road which is kept open throughout the winter. The problems of supply are, therefore, very much less than might reasonably be expected at such an altitude.

At the present moment, the Laboratory has living accommodation for four workers, with bunks, a small kitchen and bathroom. Water is obtained by melting snow with an immersion heater, the water then being pumped to a roof-tank. Waste disposal is by a double-walled heated pipe. The building itself is of aluminium and cork construction, and is securely anchored against the high winds which sweep the ridge.

The work at present going on in the Laboratory includes the exposure of nuclear plates, which in suitable weather can also be carried out up to 3,000 ft. above the Laboratory. Experiments on meson decay are also being carried on, and it is expected that later some Italian geneticists will be undertaking work at the station on mutations induced by cosmic rays. The director of the Laboratory is Prof. Gilberto Bernadini, who, with the director of the Centre for Research in Nuclear Studies, Prof. Edoardo Amaldi, is already well known in Britain for his work in this field. It is expected that at least one British physicist will be working at the Laboratory in the near future.

The inauguration ceremony was performed by Minister of the Treasury, Del Vecchio, in the presence of some sixty distinguished Italian scientific workers, and representatives of various industrial firms and the Italian Air Ministry. At the invitation of Profs. Bernadini and Amaldi, British science was represented by Dr. Tahourdin, science officer in Italy of the British Council.

VETERINARY EDUCATIONAL TRUST

THE Veterinary Educational Trust was formed in 1942, to provide for the education of graduate and postgraduate students of the best type who would not otherwise be able to proceed with their studies; means were to be found to ensure that training was provided of a type not otherwise available in Great Britain, so that veterinarians and other men of science would be equipped to undertake original research.

In the course of the ensuing years, it has been found that the original aims require to be extended. It has been decided to embark upon a plan to develop research stations dealing with the management and diseases of the different species of domesticated animals. An Equine Research Station at Balaton Lodge and Lanwades Park near Newmarket (director, Prof. W. C. Miller), a Canine Research Station (director, Mr. S. F. J. Hodgman), and also a Poultry Research Station (director, Dr. R. F. Gordon) have been opened; all these directors are veterinary surgeons.

A group of farm livestock research stations will be opened; negotiations are in progress for sites for such work. All these stations will be established within a few miles of each other and of the University of Cambridge. In developing these centres, care is being taken to ensure that there is close contact between them and the workers in the field, and there will be close co-operation with practising veterinary surgeons. The research stations will link up with a series of hospitals for large and small animals, and there will be joint laboratory diagnostic service. The aim will be to have a hospital in every county and in the larger towns.

Modern veterinary hospitals require elaborate design and equipment and cannot usually be provided by the private practitioner. Under the schemes now envisaged, they will be managed in such a way that whole-time staffs are available, and private practitioners and specialists will co-operate in the care of the patients. At the same time, the aim is to organise cadres of trained animal nurses and technical assistants, probably coupled with a system of training, certification and registration.

Since the Trust was inaugurated in 1942, forty-eight undergraduates have been awarded scholarships or studentships in the United Kingdom and Eire. Deserving students who are well embarked on their studies, but have suffered an adverse change in their financial circumstances and, otherwise, would have been unable to proceed with their studies, have been assured an opportunity of obtaining their qualifications. £7,320 has been expended on the assistance of such students. In addition, nineteen Evans Final Year Studentships have been awarded to the best students in the previous four years of study at the respective veterinary colleges.

The Wellcome Trust, the Goldsmiths Company, Messrs. Cooper, McDougall and Robertson, Ltd., the British Oil and Cake Mills, Ltd., and Imperial Chemical Industries, Ltd., have provided funds for research fellowships held under the Trust. Details have been given of eleven such fellowships now held by British veterinary and other science graduates for studies of a very varied nature at scientific institutions in the United Kingdom and the United States of America.

At the annual general meeting of the Trust, held in October 1947, a detailed account of progress was given. It was attended by an influential body of people, including, in addition to the officers of the Trust, senior representatives of the livestock and other interests concerned, such as the secretary of the Agricultural Research Council, the president of the Royal Agricultural Society of England, the president of the Royal College of Veterinary Surgeons, the president of the National Veterinary Medical Association of Great Britain and Ireland, and many others. Influential committees have been appointed to cover the several special interests concerned. The Duke of Norfolk is president and the Duke of Beaufort is the honorary treasurer. Dr. W. R. Wooldridge is the scientific director. The income for the year ended August 31, 1946, was £39,240 and the expenditure was £21,558. The assets amounted to £137,410, with a mortgage of £20,000 on property held.

Complementary to the scientific, educational and other activities, an organisation is being developed for acquainting the public throughout the country with what is being done and for collecting the money required for the operations of the Trust, the address of which is 232–35 Abbey House, Victoria Street, London, S.W.1.

VEGETABLE TANNING MATERIALS OF INDIA

THE Forest Research Institute at Dehra Dun has issued a series of Forest Leaflets dealing with the vegetable tanning materials of India (Nos. 72, 73, 74, 75 and 76, published in 1944–45).

Leaflet No. 72 dealt with a general survey of the vegetable tanning materials of India (Part 1); No. 73 with the same heading (Part 2), the tanning materials of *avaram* (*Cassia auriculata*); No. 75, the tanning materials obtained from the well-known Myrobalan (*Terminalia chebula*).

In Leaflet No. 74 (Civil and Military Press, Prem Nagar, Dehra Dun, 1945) the tree dealt with is the *Acacia arabica*, the best-known vernacular names of which are *babul*, *kikar* and *babar*. The tree has several varieties. The information given deals with the bark and the pods, their tanning content and its variation with age, part of the plant from which obtained, and the locality of its tree growth. Information is also given on the yield obtained from the bark and the pods, the quantities of bark used and its origin and price, the methods of collection and preparation for the market; the tanning properties and manufacture of the extract are also discussed.

Some data interesting to the forester are given with reference to the sylviculture of this tree, and the use of the bark and the timber are briefly dealt with. For a long period babul bark was one of the most firmly established tanning materials of India. It is now said to be losing its ground owing to two factors: it is not marketed as satisfactorily as its chief competitor, wattle bark, and there has been a failure in replacing by replanting trees as fast as they have been felled. Investigations on a wider scale are being carried on into some of these points.

In Leaflet No. 76, the black wattle (*Acacia molissima*) is discussed, with notes on other wattles growing in India, and their tanning content. In view of the remarks already made about *Acacia arabica*, this leaflet affords some valuable indications from various analyses made, such as variations in tanning content and, for black wattle, the yield of bark in South Africa and Java and the probable yield in India. Methods of collection and preparation for the market, tanning properties and manufacture of the extract are dealt with, and statistics of South African production, Indian imports and prices, and world use of wattle and other tanning materials are given. It is concluded that Indian-grown wattle could be made of equal tanning value to the South African bark, but more research is necessary.

The value of these researches into vegetable tanning materials is of obvious importance, since there are those who consider that this type of tanning material will always be superior to the chemical tannings.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 16

EUGENICS SOCIETY (at Manson House, 26 Portland Place, London, W.1), at 5 p.m.—Mr. W. Russell Brain: "Some Reflections on Genius" (Galton Lecture for 1948).*

ROYAL PHYSICAL SOCIETY OF EDINBURGH (at the Royal Scottish Geographical Society, Synod Hall, Castle Terrace, Edinburgh), at 5.15 p.m.—Prof. C. H. Waddington, F.R.S.: "Animal Development".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (at the University, Manchester), at 5.30 p.m.—Prof. R. E. Lane: "National Industrial Life and the Doctor" (Percival Lecture).*

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (at the Royal Institution, Albemarle Street, London, W.1), at 6.30 p.m.—Mr. H. W. Cremer: "Water, a National Asset" (Jubilee Memorial Lecture).

Tuesday, February 17

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the MANCHESTER SECTIONS of the SOCIETY OF CHEMICAL INDUSTRY and the ROYAL INSTITUTE OF CHEMISTRY, at the Gas Showrooms, Town Hall Annexe, Manchester), at 10 a.m.—Opening by Dr. Norman C. Wright of the Ministry of Food B.I.O.S. Exhibition; at 10.30 a.m.—Mr. F. C. White: "New Developments in the German Dairy Industry"; Mr. H. J. Bunker: "Wartime Production of Food Yeast in Germany"; at 2.30 p.m.—Mr. J. F. Hearne: "German Albumen Substitutes"; Mr. R. Perdue: "German Soapless Detergents".

ROYAL SOCIETY OF ARTS, DOMINIONS AND COLONIES SECTION (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. C. B. Symes: "Control of Insect-borne Diseases in the Colonies—Some Recent Progress and Future Prospects".

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Chemistry Department, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Prof. T. Wallace: "Methods of Determining Mineral Deficiencies in Plants"; Dr. D. J. D. Nicholas: "Chemical Tissue Tests for the Determination of Mineral Status of Plants".•

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. A. E. Mourant: "The Use of Blood Groups in Ethnology".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Mr. B. D. Richards: "Tidal Power, its Development and Utilization".

CONWAY DISCUSSION CIRCLE (at Conway Hall, Red Lion Square, London, W.C.1), at 7 p.m.—Dr. Meyer Fortes: "The Social Basis of Primitive Religion".•

ROYAL PHOTOGRAPHIC SOCIETY, SCIENTIFIC AND TECHNICAL GROUP (at 16 Prince's Gate, London, S.W.7), at 7 p.m.—Mr. G. S. Moore: "The Last Ounce of Speed".

INSTITUTION OF THE RUBBER INDUSTRY (at Caxton Hall, Caxton Street, London, S.W.1).—Symposium on "Latex".

Wednesday, February 18

BRITISH SOCIETY OF ANIMAL PRODUCTION (at the Royal Agricultural Society of England, 16 Bedford Square, London, W.C.1), at 10.15 a.m.—Annual General Meeting; General Topic: "Animals and Grass".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Dr. Sutcliffe, Mr. Priestley and Dr. Sawyer: "The Mechanics of Weather Systems".

ROYAL MICROSCOPICAL SOCIETY (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5 p.m.—Mr. Frank Baker: "Scope and Applications of Direct Microscopy to the Investigation of Starch and Cellulose Breakdown in the Digestive Tract".

OIL AND COLOUR CHEMISTS' ASSOCIATION, LONDON SECTION (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Dr. A. W. Johnson: "Synthesis from the Acetylenes, including Methods of Making Vinyl and other Polymer Resins".•

Thursday, February 19

UNIVERSITY COLLEGE LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. Kathleen Lonsdale, F.R.S.: "The Structure of Solids".•

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. A. R. Clapham and Dr. H. Godwin, F.R.S.: "Studies of the Post-Glacial History of British Vegetation", Parts 8–10.

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. Walter Frayne: "The Development and Introduction of a New Process for the Economic Recovery of Minute Quantities of Gold from Lead-Silver Bullion derived from the Bawdwin Ores"; Mr. A. L. Austen: "Notes on Labour Organisation and Performance at the Badhia Mine, Indian Copper Corporation, Ltd.".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. A. E. Taylor: "Banach Spaces of Functions Analytic in the Unit Circle".

CHEMICAL SOCIETY (in the Chemistry Lecture Theatre, University College, Nottingham), at 6 p.m.—Dr. E. R. H. Jones: "Synthesis in the Vitamin A Field".

CHEMICAL SOCIETY (joint meeting with the HULL AND DISTRICT SECTION of the ROYAL INSTITUTE OF CHEMISTRY and the UNIVERSITY COLLEGE SCIENTIFIC SOCIETY, in the University College, Hull), at 6 p.m.—Prof. E. G. Cox: "The Optical Properties of Molecules".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1) at 7.30 p.m.—Sir Edward Mellanby, K.C.B., F.R.S.: Sir Frederick' Gowland Hopkins Memorial Lecture.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Prof. B. G. Maegraith: "The Pathological Processes in Malaria"; Dr. W. H. H. Andrews: "Liver Lesions in Malaria".

Friday, February 20

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 5.30 p.m.—Lieut. P. G. Satow: "Radar and the Weather—Problems in Marine Navigation".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. E. Bradshaw, Mr. S. A. Husain, Mr. N. Kesavamurthy and Mr. K. B. Menon: "Absolute Measurement of High Voltages by Oscillating Electrode Systems".

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the INSTITUTION OF ELECTRICAL ENGINEERS, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. J. R. Rylands and Mr. J. R. Jenkinson: "Corrosion of Heating Surfaces".

MANCHESTER STATISTICAL SOCIETY, STATISTICAL METHODS STUDY GROUP (at the Society of Architects, 16 St. Mary's Parsonage, Manchester), at 5.45 p.m.—Mr. J. A. Hough: "An Analysis of Co-operative Statistics".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. R. G. Manley: "The Analysis and Interpretation of Vibration Records and similar Traces in Engineering"; Dr. F. H. Todd and Mr. W. J. Marwood: "Ship Vibration".

SOCIETY OF ENGINEERS (at 17 Victoria Street, London, S.W.1), at 6.30 p.m.—Mr. L. J. Merry: "Technical Education".

INSTITUTE OF INDUSTRIAL ADMINISTRATION, MANCHESTER CENTRE (in the Reynolds Hall, College of Technology, Manchester), at 7 p.m.—Mr. G. Chelioti: "Management and Research".

PAPER MAKERS' ASSOCIATION (TECHNICAL SECTION), NORTHERN DIVISION (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Dr. Julius Grant: "Some New View-points on the Problems of Pulp and Paper Mill Effluents".

TEXTILE INSTITUTE, DUBLIN SECTION (at the Mansion House, Dublin), at 7.30 p.m.—Mr. A. Nisbet: "Emulsions and their Use in the Textile Industry".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. C. E. Raven: "Some Neglected Aspects of the History of Science".

Saturday, February 21

INSTITUTION OF CHEMICAL ENGINEERS, NORTH-WESTERN BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 3 p.m.—Mr. P. Hamer: "Water Treatment".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, SOCIAL PHILOSOPHY SECTION (at the Portico Library, 57 Mosley Street, Manchester), at 5.30 p.m.—Prof. D. M. Mackinnon: "The Moral Implication of the Atomic Bomb".•

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LABORATORY TECHNICIAN to Hospital Physicist—The Secretary, University College Hospital, Gower Street, London, W.C.1 (February 21).

CHIEF TECHNICIAN—The Director, South London Blood Supply Depot, Benhill Avenue, Sutton, Surrey (February 21).

DEMONSTRATOR IN ANATOMY—The Registrar, The University, Sheffield (February 21).

AGRICULTURAL ECONOMIST in the Department of Agriculture and Lands, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (February 27).

LECTURER (experience in Stratigraphy or Applied Geology desirable) and ASSISTANT LECTURERS (2) IN GEOLOGY, LECTURERS (2) and an ASSISTANT LECTURER IN GEOGRAPHY, a LECTURER IN SOCIAL PSYCHOLOGY, and a LECTURER IN MORAL PHILOSOPHY—The Secretary of University Court, The University, Glasgow (March 1).

ASSISTANT LECTURER IN MYCOLOGY—The Registrar, The University, Manchester 13 (March 6).

PETROLOGIST on the Geological Survey of the Gold Coast—The Director of Recruitment (Colonial Service), 15 Victoria Street, London, S.W.1 (March 8).

CHAIR OF PSYCHOLOGY—The Secretary of University Court, The University, Glasgow (March 11).

CYTOLOGIST (Scientific Officer grade)—The Director, Welsh Plant Breeding Station, Agricultural Research Building, Penglais, Aberystwyth (March 13).

ANALYTICAL CHEMIST, and a GEOLOGIST, in the Department of Geological Survey, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (March 15).

LECTURER and an ASSISTANT LECTURER with qualifications in Pure Mathematics, a LECTURER and an ASSISTANT LECTURER with qualifications in Applied Mathematics or Mathematical Physics—The Registrar, The University, Manchester 13 (March 15).

SENIOR SCIENTIFIC OFFICERS (about 30) and SCIENTIFIC OFFICERS (about 170) in Government Departments—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, S.W.1, quoting No. 2114 (March 15).

STUDENTSHIPS at a British University in preparation for Field Research in one of the Social Sciences in the Colonial Empire—The Secretary, Colonial Social Science Research Council, Palace Chambers, Bridge Street, London, S.W.1 (March 31).

DIRECTOR OF METEOROLOGICAL SERVICES in the Department of Transport, Pretoria—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, London, W.C.2 (March 31).

CHAIR OF GEOLOGY at King's College, Newcastle-upon-Tyne—The Registrar, University Office, 46 North Bailey, Durham (April 3).

PROFESSOR in charge of the SCHOOL OF SOCIAL WORK, Victoria University College, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (April 17).

I.C.I. FELLOWSHIPS for research in chemistry, physics, and allied subjects—The Registrar, The University, Manchester 13 (April 30).

TURNER AND NEWALL FELLOWSHIPS for research in engineering, inorganic chemistry, physics, and allied subjects—The Registrar, The University, Manchester 13 (April 30).

CHAIR OF ORGANIC CHEMISTRY—The Registrar, The University, Sydney, Australia (May 31).

ANALYTICAL CHEMIST at the Tung Experimental Station, Nyasaland—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1.

SENIOR TECHNICIAN IN THE DEPARTMENT OF INDUSTRIAL METALLURGY—The Professor of Industrial Metallurgy, The University, Edgbaston, Birmingham 15.

GOOD INSTRUMENT MAKER (Ref. Chemistry/2), and a TECHNICIAN with knowledge of electricity (Ref. Chemistry/3), in the Department of Chemistry—The Secretary, University College London, Gower Street, London, W.C.1.

RESEARCH FELLOWSHIP for advanced archæological research in Turkey—The Hon. Secretary, British Institute of Archæology at Ankara, c/o Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1.